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Founded by J. A. Nieuwland, C.S.C.

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Parasitic Copepods from Gulf of Mexico Fish

Ruby Bere

Except for one species, *Gloiopotes crassus*, which was collected at Ft. Lauderdale, Florida, the parasitic copepods discussed in this paper were taken from fish caught in Lemon Bay and vicinity during the winter and spring of 1934-35 while working at the Bass Biological Laboratory, Englewood, Florida, and it is indeed a pleasure to express my appreciation to Mr. John F. Bass, Jr., for the opportunity of making this study.

The identification of the material has been greatly facilitated by Dr. C. B. Wilson in whose laboratory the manuscript has been prepared for publication and I wish to tender him my most sincere thanks for his kindly and generous assistance.

Slightly more than a thousand fish were examined, all but forty-seven being marine. The latter came from either a small pond two miles east of Englewood or from roadside ditches. Of the marine fish, more than one-third were elasmobranchs of which approximately forty-six per cent were parasitized, whereas but thirty-two per cent of the other fish were infected with parasitic copepods. A few species of fish yielded no copepods due no doubt to the smaller number of specimens examined. However, a catch of fifty-two croakers *(Micropogon undulatus)* all proved to be negative.

As practically no work has been done on Florida fish it is not surprising that the investigation has yielded many new species of parasitic copepods—sixteen, including three new genera—as well as new records of species already known from European waters and the males of two previously described species. The types of all the new species and specimens of those for the first time obtained from American localities have been deposited in the U. S. National Museum under the numbers here designated.

A description of the new species follows. In addition a number of species are redescribed and new drawings furnished.

Argulidae

Argulus funduli Krøyer

Pl. 1, Fig. 1

Occurrence.—A single male of this species was taken from a pinfish *(Lagodon rhomboides)*.

Color.—Before preservation, it was noted that the body had a stippled, grey appearance with a band of white around the margin of the abdomen and

that the testes were covered with brown spots. Formalin produced a rather striking change, the body now being a light brownish yellow with symmetrically arranged dark brown patches, as shown in Fig. 1. Total length 2 mm.

Remarks.—This immature specimen differs from Wilson's description in that there are only thirteen segments in the supporting rods of the sucking disk instead of eighteen to twenty.

Argulus laticauda Smith

Occurrence.—Very abundant on the stingaree *(Amphotistius say)* and the butterfly ray *(Pteroplatea maclura)*. In addition, one specimen was found on the toadfish *(Opsanus tau)*.

Argulus fuscus sp. nov.

Pl. 1, Figs. 2-10

Occurrence.—One female was found on the tail of a hogfish *(Orthopristis chrysopterus)* and about two months later a male specimen was obtained from a silver perch *(Bairdiella chrysura)*.[1]

Female.—Carapace nearly twice as long as wide and slightly overlapping the base of the abdomen; posterior lobes well rounded; posterior sinus very narrow, one-third the length of the carapace. Respiratory areas of unequal size, the anterior one small and egg-shaped, the posterior one the same width but twice as long. Abdomen less than half the length of the carapace, the anal laminae basal; posterior lobes tapering to a point, their inner margins parallel, the sinus between them over half the length of the abdomen.

Basal joint of first antenna with a long, sharply bent lateral claw, a stout spine at the anterior inner corner and another one of the posterior margin; second joint long and slender, armed distally with two spines; terminal joint half as long and armed with a tuft of apical spines. Second antenna 4-jointed, the basal one armed posteriorly with a strong spine and a number of setae, the following joints each successively shorter and bearing a tuft of setae anteriorly.

The supporting ribs of the sucking disk are made up of eight closely adjacent disks plus an elongated basal segment. Triangular plate on basal segment of maxilliped almost entirely covered with spines, the two inner teeth short and blunt, the outer one larger, truncate and thickened distally; anterior distal corner of second segment produced into a large bluntly rounded spine and covered with scale-like spines; the next segment is longer but very much narrower and profusely armed with spines; the penultimate segment is very short and its anterior half is covered with spines; the distal segment terminates in a curved process and is provided with two spines.

There are no flagella on any of the legs; the lobe on the fourth pair is quite small; the ventral surface of the basipods is covered with spines.

Total length 7 mm.; width of carapace 3 mm.; length of abdomen 2 mm.

Male.—Half the length of the female but carapace relatively wider and

1 The two have been deposited in the National Museum as types of the new species with Cat. No. 69850.

abdomen more than half its length; anal sinus V-shaped, about one-third the length of the abdomen.

Both pairs of antennae as in female. First two segments of maxilliped not as heavily armed as in female, the three teeth of equal size, short and bluntly rounded; no spine on second segment. Posteriorly, the basal joint of the third pair of legs has an elliptical depression, the surface of which is roughened; opposite this area, on the anterior border of the basal joint of the fourth pair, is a spherical knob whose surface has a scaly appearance.

Total length 3.5 mm.; width of carapace 1.65 mm.; length of abdomen 1.29 mm.

Color.—Both sexes are a rich dark brown in color except for the tips of the abdominal lobes, a small area around the brain and a triangular area around each eye, all of which are white.

Remarks.—The specific name has reference to the color.

Argulus varians sp. nov.

Pl. 1, Figs. 11-16

Occurrence.—Five females were obtained, two from the batfish *(Ogcocephalus* sp.) and one each from a pinfish, a sucking fish *(Echeneis naucrates)* and a spiny toadfish *(Chilomycterus spinosus)*.[2]

Female.—Carapace longer than wide with evenly rounded lobes and wide posterior sinus. In the suckingfish specimen, the lobes extend to the anterior border of the third segment; in the specimen from the spiny toadfish they just reach the base of the abdomen, while in the batfish specimens they cover the anterior portion of the abdomen. Anterior respiratory tract small, elliptical; posterior area wider and twice as long with scalloped margin. Abdomen a little longer than wide with short pointed lobes and a V-shaped sinus less than one-quarter the length of the abdomen, and spreading outward widely; papillae basal.

First and second antennae of the usual pattern, the latter 5-segmented, the basal segment with a stout posterior spine, the second, third and fifth segments with minute setae, the fourth segment unarmed.

The supporting rods of the sucking disk are made up of three or four small segments and a basal portion about three times their individual length. The angular maxillipeds are well armed with scales and spines, the former divided into four to seven fine points; the triangular plate is also provided with many scales on its ventral surface and its three posterior spines are moderately long and bluntly rounded.

Swimming legs without flagella. The posterior portion of the basal segment of the fourth legs, including the small lobe, is covered with spines and setae. The lobe is better developed in the suckingfish specimen than in the others.

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2 This last specimen has been placed in the National Museum as the type of the new species with Cat. No. 69853.

Total length 5.7 mm.; width of carapace 3.3 mm.; length of abdomen 1.4 mm.

Color.—Margin of abdomen and carapace white or light grey, the interior portions a light yellowish brown or rust; semen receptacles a darker shade; marking on carapace dark brown.

Remarks.—The specific name calls attention to the variation in the length of the carapace and the lobes of the fourth legs.

Argulus bicolor sp. nov.

Pl. 2, Figs. 17-23

Occurrence.—A female of this new species was found on a needlefish *(Strongylura notata),* a male on a sand bream *(Archosargus unimaculatus)* and two additional specimens were taken free in the bucket in which these fish, together with several other species, had been placed. Consequently, the natural host of this *Argulus* is in doubt. Types, a male and a female with Cat. No. 69863, U.S.N.M.

Female.—Carapace a little longer than wide; frontal sinuses deep, leaving a well defined cephalic area; posterior lobes well rounded, partially covering the last thoracic segment in one specimen, in another completely covering it; sinus nearly one-third the length of the carapace and widening posteriorly. Anterior respiratory area small, elliptical; posterior one a little wider, over three times as long and curved. Abdomen almost one-quarter the total length, one-fourth longer than wide with outer margins almost straight and parallel; sinus V-shaped, more than half the total length, spreading outward widely; papillae basal.

First and second antennae of usual type. Sucking disks very similar to those of *A. fuscus;* ribs with seven crescentic disks and a longer basal segment. Teeth of plate of maxillipeds short and bluntly rounded, the inner two closer together; spines on second segment and some of those on third segment scaly in appearance and tripartite.

Swimming legs without flagella. Basal segment of fourth legs with small lobe bearing spines; posterior portion of this segment covered with setae; remainder armed with spines.

Total length 4 mm.; width of carapace 2 mm.; length of abdomen 1.1 mm.

Male.—Carapace relatively longer than in female, extending beyond the base of the abdomen. In the preserved specimen the posterior lobes overlap nearly obliterating the sinus. Abdomen less than one-third the total length, lobes inclined towards the center; anal sinus more than half the abdominal length.

Appendages as in female. Basipods of swimming legs armed with spines: posterior legs not modified.

Total length 3.2 mm.; width of carapace 2.5 mm.

Color.—In the living condition this species is very beautifully colored. The cephalic area is a greyish green, the thorax mottled with small black spots. the lobes a mixture of green and rust, the latter pigment in narrow bands radiating from the margin of the carapace. The abdomen is also greyish

green with a tinge of rust, the outer border being white; semen receptacles rust colored.

Remarks.—The specific name merely calls attention to the coloration of the animal, green and rust color predominating.

Ergasilidae

Ergasilus manicatus Wilson

Occurrence.—Found on the gills of *Jordanella floridae* and *Gambusia holbrooki* which were caught in a roadside ditch; a few specimens.

Ergasilus lizae Krøyer

Pl. 2, Figs. 24-35

Ergasilus lizae Krøyer, Naturhist. Tidsk., ser. 3, vol. 2, p. 232, 1863.

Occurrence.—On the gills of the mullet *(Mugil cephalus* and *M. curema)*, the broad killifish *(Floridichthys carpio)*, *Fundulus similis* and *F. heteroclitus grandis*. A single female has been placed in the National Museum with Cat. No. 69851.

Female.—Cephalothorax more than half the entire length, violin-shaped with deep lateral sinuses, the anterior portion being longer and wider. Remainder of body narrower and diminishing regularly in width; genital segment slightly wider than long; abdomen 3-segmented, each one decreasing slightly in length and width. Anal laminae as long as wide, each one armed with three setae, the inner one longer than the combined genital segment and abdomen.

First antennae 6-segmented, the basal joint much shorter than those following, well armed with long setae. Second antennae long and slender, 3-segmented plus a terminal claw. Mandibles 2-segmented with two finger-like processes which are armed on their posterior margins with a row of fine hairs. First maxillae palp-like tipped with two setae. Basal portion of second maxillae large, narrowed distally into a short neck from which arises the terminal joint which is densely covered with spines.

Rami of first four pairs of legs 3-jointed with the exception of the fourth exopod which is only 2-jointed. The armature of the first endopod differs somewhat from that of the other rami—the first two segments have a long non-plumose seta at their inner distal corner, the third segment has four such setae plus two spines; the setae of the other rami of the plumose type. Fifth legs 1-segmented, elongate, tipped with two setae.

Total length .84 mm.; length of cephalothorax .48 mm.; width of same .34; egg strings .55 mm. long.

Remarks.—This species has not been reported since 1863 when it was described by Krøyer from specimens obtained from the gills of the mullet at New Orleans. Krøyer furnished no drawings but the present material agrees in general with his description although differing in a number of details.

Bomolochidae

Tucca impressus Krøyer

Occurrence.—A few specimens were found under the pectoral fin of the spiny toadfish *(Chilomycterus spinosus).*

Bomolochus nitidus Wilson

Occurrence.—A few specimens were found inside the branchial cavity of the needlefish *(Strongylura timucu).*

Bomolochus teres Wilson

Occurrence.—Attached to the inner surface of the operuculum of the menhaden *(Brevoortia tyrannus);* a few specimens.

Caligidae

Caligus bonito Wilson

Occurrence.—Found in the mouth of the bluefish *(Pomatomus saltatrix)* and the Spanish mackerel *(Scomberomorus maculatus),* in the mouth and on the body of the mangrove snapper *(Lutianus griseus),* the mullet *(Mugil cephalus)* and the leather jack *(Oligoplites saurus),* and in the branchial cavity of the kingfish *(Scomberomorus cavalla);* abundant.

Caligus haemulonis Krøyer

Occurrence.—In the mouth of the black drum *(Pogonias cromis),* in the mouth and on the body of the sea-cat *(Galeichthys felis)* and the gafftopsail *(Bagre marina),* in the mouth, spiracles and on the body of the whipparee *(Stoasodon narinari),* and on the spadefish *(Chaetodipterus faber);* common.

Caligus mutabilis Wilson

Occurrence.—Found on the dorsal surface of the electric ray *(Narcine brasiliensis)* and on the body and in the branchial cavity of the pompano *(Trachinotus carolinus);* rare.

Caligus rapex Milne Edwards

Occurrence.—A few specimens were taken from the outer surface of the hogfish *(Orthopristis chrysopterus).*

Caligus robustus Bassett-Smith

Occurrence.—On the outside surface of the hardtail *(Paratractus crysos)* and in the branchial cavity and on the body of the jackfish *(Caranx hippos);* in small numbers.

Caligus rufimaculatus Wilson

Occurrence.—In the mouth cavity of the bluefish, in the mouth and on the outer surface of the mullet and leather jack, around the mouth of the devilfish (probably *Mobula hypostoma),* on the outside of the whipparee, the guitarfish *(Rhinobatus lentiginosus),* the spadefish the needlefish and the mo-

jarra *(Eucinostomus pseudogula);* also in surface tows in Lemon Bay; common.

Caligus praetextus sp. nov.

Plate 3, Figs. 36-70, Pl. 4, Figs. 71-76

Occurrence.—Found in the mouth, in the spiracles, in the branchial cavity or on the outer surface of the shovelhead shark *(Reniceps tiburo),* the clear-nosed skate *(Raja eglanteria),* the stingaree, the butterfly ray, the whipparee, the sea-cat, the mullet, the snook *(Centropomus undecimalis),* the spot snapper *(Lutianus synagris),* the hogfish, the pinfish, the mojarra *(Eugerres plumieri),* the silver perch, the whiting *(Menticirrhus americanus),* the spadefish and the suckingfish; very plentiful.[3]

Female.—Carapace slightly more than half the total length, narrow in the region of the frontal plates but widening posteriorly to almost equal the length; median portion projecting beyond the posterior lobes; lunules small and semicircular. Fourth segment narrowed to slightly more than one-quarter the width of the carapace. Genital segment flask-shaped, without lobes, half the length of the carapace and the same width as its median lobe. Abdomen 1-segmented, half the length of the genital segment but less than half its width, narrowing posteriorly; caudal rami large, twice as long as wide, inclined towards the midline with three terminal plumose setae which are as long as the combined length of the abdomen and caudal rami.

Terminal claw of second antenna long and sharply bent near the tip with an accessory spine; basal segment produced posteriorly into a large spine; middle segment with a small, semicircular ridged area. Prehensile hook large, slightly curved with two small papillae at the base, each bearing three long hairs. First maxilla large, simple, slightly curved; maxillary palp with one long and two shorter setae. Second maxilla of usual type with a sharp spine near the distal end and terminating in two curved claws, to each of which is attached a pair of membranous pectinate flanges (Fig. 39). Basal segment of maxilliped large, terminal claw as long as distal segment with accessory spine at its base. Base of furca shorter than the distal portion which has a U-shaped sinus the branches being parallel and broad with bluntly rounded tips.

First legs 3-segmented, the basal segment with a long spine on its distal end, a shorter one on the posterior margin towards the base and a minute, blunt 2-segmented endopod at the distal end; middle segment longer than the other two with a short spine at its anterior distal corner; terminal segment with three bifurcated claws, one ramus of each claw surrounded by a narrow transparent flange, and a long seta also bordered by a flange and finely fringed on the convex margin. The second and third legs are of the usual pattern. Fourth legs 3-segmented with three terminal and two lateral claws; at the base of each claw there is a small spine surrounded by a transparent flange.

[3] A male and female have been placed in the National Museum to serve as types of this new species with Cat. No. 69861.

Total length 4.4 mm.; length of carapace 2.25 mm.; width of same 2.10 mm.

Color.—Carapace creamy, with or without small dark brown pigment spots around the edge or scattered over the whole surface; in some specimens the carapace has a greyish tinge. Genital segment white, grey or brown with a variable number of pigment spots which were dark brown or a rusty color and much branched; in some specimens the center of the pigment spots was dark red with the radiating branches a lighter shade. Eyes dark brown, black or red. Egg strings grey.

Male.—Carapace more than half the entire length and relatively longer than in the female but otherwise similar except that it does not widen posteriorly to the same extent. Genital segment spindle-shaped, shorter than the abdomen, which is 2-segmented, the basal half the length of the anal segment. Caudal rami and setae as in female.

Of the appendages, only the second antenna, the first maxilla and the maxilliped differ from those of the female. The second antenna is large, the second joint partially thrown into narrow folds, the terminal claw short but stout and divided distally into three parts. Prehensile hook more slender than in female and without basal palps. Distal portion of first maxillae transversely lined. Basal segment of maxilliped large with a stout spine; terminal claw slender with an accessory spine at the base. Second maxilla, furca and swimming legs resemble those of the female.

Total length 3.2 mm.; length of carapace 1.8 mm.; width of same 1.7 mm.

Color.—Body creamy or light brown with or without small dark brown pigment spots on the edge of the carapace and genital segment; in some specimens those on the latter were a lighter shade but more branched.

Five chalimus specimens, representing three different stages of development (to be referred to as a, b and c) were obtained from the tail of the hogfish to which they were attached by the frantal filament. The hogfish is one of the many hosts of the adult form. These specimens were grey in color with a few very small black pigment spots.

Chalimus a (Fig. 50).—Carapace elongate, posterior margin almost truncate covering only the first two thoracic segments; neither lunules nor dorsal grooves in evidence and position of posterior sinus indicated by a groove; eyes a little nearer the posterior margin than the anterior end. Third and fourth segments marked by lateral invaginations, the latter somewhat narrower and shorter. Genital segment and abdomen of about equal size and sub-quadrangular. Caudal rami about as long as wide with one long inner seta and four very short ones.

First antennae 2-segmented, without setae except at the tip. Second antennae very small, composed of a single elliptical segment and tipped with a short blunt spine which will probably develop into the claw of the adult. The first maxillae are not apparent but the mandibles seem to be as well developed at this stage as they are in the adult. The second maxilla has as yet only one claw, the outer one being in a rather rudimentary stage; both are fringed with

fine spines. The distal segment of the maxilliped is relatively longer than in later stages and the accessory spine is present at the point where a groove will later mark off the claw. The furca is not represented in this stage, not even its position being indicated.

The exopod of the first swimming legs is unsegmented but there is a slight lateral invagination and a short spine at the point where the groove will appear; it is tipped with five setae and there are also two lateral setae; the endopod is also unsegmented and considerably larger than in any of the later stages. The rami of the second and third legs are 1-segmented, the endopods of both a little shorter than the exopods; neither are as well armed as in later stages. Fourth legs uniramose, the two segments of nearly equal size and tipped with two very small spines. Fifth legs not present.

Total length 1.4 mm.; width of carapace .48 mm.

Chalimus b (Fig. 57).—This specimen is considerably more advanced than the preceding one and already quite suggestive in appearance of the adult male. The invagination of the lunules has begun, the dorsal grooves of the carapace and the posterior sinuses are present, and the eyes are in a more anterior position. The third thoracic segment is no longer exposed and the fourth segment is now definitely marked off from the genital segment, which is wider than the abdomen as in the adult. The abdomen is still 1-segmented but lateral invaginations suggest later segmentation. The caudal rami are now longer than wide and are armed with three long setae and two very short ones.

The first antennae are very setose, the distal segment not nearly as slender as in the adult. The second antennae already show indications of the 3-clawed adult male condition. The first maxillae are now well developed but the maxillary palp has a rather claw-like seta. The outer claw of the second maxilla is half the length of the inner one. The distal segment of the maxilliped is relatively shorter than in the previously described stage but the claw is not as yet marked off. The furca is represented by two completely separated elliptical knobs, the future furcal rami.

The first legs are 2-segmented but the second segment is much shorter than in the adult; the terminal claws are neither divided nor flanged; the endopod is considerably reduced in size but still unsegmented. The rami of the second legs are 3-segmented as in the adult and similarly armed. The third legs are also rapidly assuming the adult form, the exopod being 3-segmented, the endopod 1-segmented. The fourth legs are still 2-segmented but have lengthened considerably and are now armed with five spines. No fifth legs observed.

Total length 2.8 mm.; width of carapace .96 mm.

Chalimus c (Fig. 65).—Carapace much like that of chalimus b but the lateral lobes are narrower and the median lobe wider. Genital segment and abdomen are of equal length, the former being a little broader but it has not yet assumed the shape of the adult female. Caudal rami unchanged.

First antennae and lunules as in the adult but the second antennae still have an immature appearance, the terminal claw being quite stout. First

maxillae unchanged. Both claws of the second maxillae have increased in length but are still simple in form. The maxilliped claw is now marked off but otherwise this appendage is unchanged. The two knobs of the furca have united and the basal portion has also been developed. The swimming legs are practically in the same state as in chalimus b.

Total length 3.48 mm.; width of carapace 1.2 mm.

Remarks.—*Praetextus* = margin or fringe, referring to the membranes around the claws of the first swimming legs.

Echetus typicus Krøyer
Pl. 4, Figs. 94-98

Echetus typicus Wilson, Proc. U. S. Nat. Mus., vol. 28, p. 611, pl. 17, figs. 196-205, 1905.

Occurrence.—A single male, together with two females, was found inside the gill cavity of a redfish *(Sciaenops ocellatus)*.[4]

Male.—Carapace slightly longer than wide and constitutes a little less than half the total length; posterior sinuses wide and shallow with the median lobe projecting a little beyond the lateral lobes. Lunules large and nearly circular. Free thoracic segment spindle-shaped, almost as long as wide. Genital segment less than half the length of the carapace and three-quarters the length of the abdomen, subrectangular in shape with very small lobes. Abdomen 2-segmented, the terminal one longer than the basal. Caudal rami long, about equal in length to the first abdominal segment and tipped with three long plumose setae and a shorter one.

First antennae heavily armed with plumose setae; distal joint tipped with a number of nonplumose setae. Second antennae modified in much the same way as are many Caliginae; the middle segment is thrown into a series of narrow folds giving it a corrugated appearance and posterior to the appendage itself is another such area. First maxillae slightly curved but the same width throughout and bluntly rounded at the tip with a small palp bearing one long and one short seta. Second maxillae resemble those of the female being 2-segmented with two stout apical claws, the outer one much the shorter. Terminal claw of maxilliped strongly curved as in the female but is here furnished with an accessory spine.

The four pairs of thoracic legs resemble those described for the female, the basal joints of the first legs being long and narrow, and the fourth legs with only two segments, the distal one armed with three straight terminal spines and a lateral one, all with a narrow marginal flange. Fifth legs represented by three small spines at the outer corners of the ventral surface of the genital segment.

Total length 2.4 mm.; length of carapace 1.1 mm.; width of same 1 mm.

Remarks.—This species was originally described as a lernaeid by Krøyer from headless specimens and it was not until 1911 when Wilson obtained

4 The male becomes the male type of the species with Cat. No. 69854, U. S. N. M.

complete specimens that it was assigned to its proper position among the *Caliginae*. The size of the male is in striking contrast with that of the female which attains a length of nearly 25 mm. That the present specimen is the male of *Echetus typicus*, which has not hitherto been described, and not merely a species of *Caligus* becomes evident from a comparison of the appendages of the two sexes. The second maxillae and fourth legs of this male are similar to those of the female of *E. typicus*, but very different from those of a male of the genus *Caligus*.

Sciaenophilus benedeni Bassett-Smith

Occurrence.—A few specimens found inside the branchial cavity attached to the operculum of the banded drum *(Larimus fasciatus)*.

This genus has not heretofore been reported from American waters.

Abasia pseudorostris Wilson

Occurrence.—Half a dozen specimens were found in the mouth of the lizard fish *(Synodus foetens)*.

Tuxophorus caligodes Wilson

Occurrence.—A few specimens were taken from the outer surface of the pompano *(Trachinotus carolinus)*, the permit *(Trachinotus falcatus)* and the suckingfish *(Echeneis naucrates)*.

Lepeophtheirus marginatus sp. nov.

Pl. 4, Figs. 77-93

Occurrence.—Specimens of both sexes were found in limited numbers on the outer surface of several hosts—one female each from a butterfly ray and a whipparee, one male from a shovelhead shark and a number of both sexes from the sea-cat and in the mouth of the gafftopsail. It has also been collected from a sea catfish *(Galeichthys* sp.) at Pass Christian, Mississippi. A single male and female have been selected for the types of the new species with U.S.N.M. No. 60548.

Female.—Carapace almost circular in outline, very slightly longer than wide; posterior sinuses narrow and inclined towards the center. Free thoracic segment narrow, about one-third the width of the median lobe of the carapace. Genital segment acorn-shaped, without lobes, narrowed to a short neck where it joins the fourth segment, nearly squarely truncated posteriorly. Abdomen small, almost square, one-third the width of the genital segment, with very short caudal rami each bearing three long plumose setae and a short spine on either side of them. Egg strings short, as wide as abdomen.

First antennae long and slender; the second pair converted into a strongly curved and very acuminate claw. First maxillae long and slender; second maxillae with two irregular-shaped protuberances on the basal joint and three terminal claws. Maxillipeds small and rather slender with an accessory spine at the base of the claw. Rami of furca surrounded by a wide transparent

membrane; outer margins convex, the inner ones straight and parallel leaving a U-shaped sinus.

First legs 3-jointed, the basal joint with a long bent plumose seta at the anterior distal corner and a shorter one near the posterior proximal corner; near the posterior distal corner is a large blunt club-shaped process fringed with short hairs, the rudimentary endopod; the second joint bears a short spine at its anterior distal corner; the distal portion of the three terminal claws of the third segment is surrounded by a narrow transparent flange; the posterior margin of this joint bears three rather short, weak plumose setae and a short spine. The second and third legs are of the usual type. The fourth legs are 4-segmented with three terminal and two lateral spines; at the base of each terminal claw and the second lateral one there is a small semi-elliptical membrane. Fifth legs very small situated on the ventral surface of the genital segment just in front of the egg strings; each consists of a small semicircular knob tipped with three plumose setae.

Total length 3 mm.; length of carapace 1.5 mm.; width of same 1.3 mm.; length of egg strings 1.14 mm.

Male.—Carapace relatively longer than that of the female but otherwise similar. Genital segment barrel-shaped, longer than wide, narrowed anteriorly to form a short neck. Abdomen 1-segmented, slightly longer than wide, narrowed a little where it joins the genital segment. Caudal rami as in female.

Appendages like those of the female with the exception of the second antennae and the furca. The short terminal joint of the former is armed with three stout curved claws; the first and second segments have a corrugated appearance where the outer surface is thrown into narrow overlapping folds. The furcal branches are much wider than in the female, the transparent flanges meeting in midline and almost obliterating the sinus; the outer margin of each is strongly convex. Rudimentary fifth and sixth legs are present near the lateral margin of the genital segment, the former half way down and possessing four setae, the latter occurring at the posterior corners and armed with three setae.

Total length 2.5 mm.; length of carapace 1.5 mm.; width of same 1.35 mm.

Color.—Frontal plates colorless; carapace light creamy or grey; genital segment, abdomen and edge of carapace covered with dark blue or purple pigment spots which are much branched and confluent; eyes black or dark red.

Immature female.—Carapace resembles that of the adult in being almost circular but the peculiar pattern was not observed. Genital segment considerably wider than long but the abdomen has assumed the adult form being subquadrangular with slightly convex sides. The appendages are also in the adult state although the furcal branches are more curved and inclined towards the center.

Total length 2.64 mm.; length and width of carapace 1.56 mm.

Immature male.—Carapace elliptical whereas in the adult it is very nearly circular, but the fourth and genital segments and the abdomen are all relatively broader than in the adult.

The second antennae are still in a rather simple form, the terminal claws not yet having been developed. Second maxillae not as slender as in the final stage; the claws are stouter and shorter but the protuberances on the basal segment are already in evidence. The furcal branches are broad but much shorter than in the adult and the flanges are as yet very narrow. First legs relatively less slender than in adult and the flanges around the terminal claws are barely discernible; the rudimentary edopod is relatively larger. Fourth legs 2-segmented with four of the claws terminal and only one lateral, all being considerably shorter than in the adult. The other appendages are similar in structure to those of the adult.

Total length 1.4 mm.; length of carapace .9 mm.; width of same .7 mm.

Remarks.—The specific name, *marginatus*, has reference to the transparent membrane or flange surrounding the furca and the claws of the first pair of legs.

Lepeophtheirus eurus sp. nov.

Pl. 5, Figs. 99-108

Occurrence.—A single female was found on the outer surface of a spot-tip ground shark *(Carcharias limbatus)*.[5]

Female.—Carapace as wide as long, posterior sinuses shallow, narrow and inclined towards the center. Free thoracic segment very short and less than half the width of the median lobe of the carapace. Genital segment slightly wider than long and two-thirds the length of the carapace, narrowed anteriorly into a short neck the width of the free segment, posterior margin concave. Abdomen one-half the length of the genital segment, twice as long as wide. 2-segmented, basal segment short, one-third as long as the distal. Caudal rami large with three plumose setae and an outer short spine.

Claw of second antennae long and slender, sickle-shaped, basal segment with a long blunt spine. Prehensile hooks large, curved. First maxillae long, slender, acuminate. Second maxillae 2-jointed with a spine near the distal end of the second segment which is tipped with a long seta and a much shorter spine, both with pectinate margins. Furca large, rami bifid, outer branches longer and divergent, the two inner branches parallel and shorter. Maxilliped with large claw provided with an accessory spine.

First legs 3-segmented, the basal one carrying the large, 3-segmented rudimentary endopod; the distal segment terminating in four claws, the posterior being one-third the length of the first. The outer distal corner of the basal joint of the endopod of the second legs is armed with twenty-five curved teeth, otherwise they conform to type. Fourth legs short, 3-segmented, basal joint equal to the combined length of the two terminal ones, armed with one lateral spine and two apical ones in addition to a very long apical seta, all with marginal pectinate membranes.

Total length 3.4 mm.; width of carapace 1.7 mm.; width of genital segment 1.2 mm.

[5] This becomes the type of the new species with Cat. No. 69859, U. S. N. M.

Color.—Carapace creamy with a greyish tinge in the lateral areas due to fine stippling, which is less dense in the central portion. Genital segment and abdomen with fine grey tracery and purple pigment spots; ovaries grey. Eyes black.

Remarks.—The specific name has reference to the great breadth of the genital segment.

Pupulina flores van Beneden

Pupulina flores Wilson, Parasitology, vol. 27, p. 593, text figures 1-13, 1935.

Occurrence.—Found on the outer surface, around the mouth of a devilfish (probably *Mobula hypostoma)* in company with *Caligus rufimaculatus.*

Color.—The carapace of a large female had a bluish white tinge, that of the smaller females was creamy with much branched reddish purple pigment spots; genital segment and egg strings rose colored; eyes black.

Remarks.—This species has just recently been redescribed by Wilson after more than forty years of obscurity from specimens taken from *Manta birostris* and the color notes given above complete the account.

Trebidae

Trebius caudatus Krøyer

Occurrence.—A single female was found on the outer surface of a butterfly ray *(Pteroplatea maclura).*

Euryphoridae

Gloiopotes crassus Wilson et Bere, spec. nov.

Pl. 5, Figs. 109-11, Pl. 6, Figs. 125-155

Occurrence.—A single adult male and female and an immature female were obtained from the body of a spearfish sucker *(Rhombochirus osteochir)* in addition to a number of chalimi from the gills of the same host which was attached to a sailfish caught at Ft. Lauderdale, Florida. Wilson also obtained a single female from the same host which was attached to a billfish *(Tetrapturus imperator)* caught at Miami, Florida, and gave it the manuscript name above.[6]

Female.—General body form stout and strongly depressed; cephalothorax as wide as long and subquadrangular, widest posteriorly; lateral lobes short and wide, not quite reaching the posterior margin of the median lobe. Fourth segment very short with a pair of minute dorsal wings which do not reach the lateral margins. Genital segment half the width and length of the cephalothorax with convex sides and a long rounded posterior lobe on either side of the abdomen reaching beyond the center of the anal segment. To the under surface of the lobe just outside the egg case is attached a process reaching but little beyond the tip of the lobe. These processes are slightly enlarged at the base on the inner side but for the remainder of their length are nearly uniform

6 A male and female have been selected as types of the new species with Cat. No. 69862, U. S. N. M.

in width. Both margins are bordered with a narrow transparent membrane, which is divided at short intervals. Each process is armed with a filiform apical seta and two much shorter ones on the outer margin. Abdomen 2-segmented, the segments about the same width and length; caudal rami as long as the anal segment; narrowed at either end and dilated through the center, each with three apical setae and one on the outer margin near the tip, all about equal in length and scarcely half the length of the ramus itself. Egg cases stout and a little longer than the cephalothorax.

First antennae slender and fairly long. Second antennae 2-segmented, with a stout terminal claw, strongly curved; second segment less than half the length and width of the basal segment. First maxillae bifurcate, the outer ramus a little shorter and stouter than the inner. Second maxillae long and slender, the distal joint with a stout spine on its inner margin and terminating in two curved claws, the outer shorter one finely toothed, the inner one with a narrow flange along its convex margin. Mandibles long and slender, the terminal portion curved and finely serrate. Basal joint of maxilliped large, terminal claw curved, acuminate and about half as long. The basal portion of the furca is slightly narrowed anteriorly; the branches are acute and divergent leaving a wide V-shaped sinus.

The first legs are apparently 4-segmented but what seems to be a very short second segment is really the articulation between the first two segments stretched a little. The basal and third segments are longer than the other two; the terminal segment carries four apical claws, diminishing in length posteriorly, and three plumose setae on the posterior margin. Rami of second legs 3-segmented, armed with very long plumose setae; a stout spine occurs at the outer distal corner of the first two exopod segments and two such spines are present on the third segment. The rami of the third legs are set very close together; exopod 3-segmentd with a very large curved spine overlying the basal joint; endopod 2-segmented with plumose setae. Fourth legs 4-segmented, basal joint dilated and as long as the three terminal segments combined; two of the latter carry a spine at the outer distal corner, the first one being very short, and the terminal segment has three apical spines, the inner one three times the length of the outer; a small semicircular fringed membrane lies over the base of each of these spines and all but the first one are pectinate on both margins.

Total length 7.25 mm.; width of carapace 4 mm.; length of egg string 4 mm.

Male.— Carapace similar in shape and markings to that of the female. Fourth segment short, nearly as wide as the median lobe of the carapace and without the rudimentary dorsal plates of the female. Genital segment nearly circular, without lobes, one-third the width of the carapace. The processes are very much reduced in size and are each armed with an apical and two lateral setae. Abdomen 2-segmented, the posterior joint slightly wider and longer. Caudal rami large, as long as the anal segment, tipped with four long plumose setae.

Basal joint of first antennae large and bearing a thick fringe of setae along

the anterior border; terminal joint narrow with an apical tuft of setae. Second antennae 2-segmented, the basal segment about one-third the length of the terminal which bears a large curved claw provided with an accessory spine; the surface of the two joints is partially roughened. The prehensile hook is simple, slightly curved with bluntly pointed tip. Mandible 3-segmented, slender, distal segment curved and serrate. The first maxillae differ from those of the female, the outer ramus being much shorter and narrower; overlying the inner ramus is a transparent bluntly rounded spine and at the junction of the two on the inner margin there is a second but shorter transparent spine; the palp is in the form of a small rounded papilla bearing two slender setae. The second maxillae and furca resemble those of the female but one of the second maxillae had apparently been injured for the terminal claws were replaced by a very small curved spine. The maxillipeds are provided with a stout claw which carries an accessory spine; the basal joint is large with a divided spiny knob on its inner surface. The swimming legs are similar to those of the female.

Total length 5 mm.; length of carapace 3 mm.; width of same 2.9 mm.

Immature female (Fig. 109).—Carapace markings and shape similar to adult but frontal filament gland still visible. Fourth segment much longer but genital segment considerably smaller with straight sides. The dorsal plates on the fourth segment are about the same size as in the final stage. Abdomen 2-segmented, the basal one being much shorter than in the adult; caudal rami as large as in the adult. The posterior processes are as wide as the posterior lobes of the genital segment and appear to be a continuation of them as if formed from them by segmentation.

The two pairs of antennae are much like those of the adult. The first maxillae are bifurcate but the inner branch is only half the length of the outer. The second maxillae are not as slender and the inner claw is not serrate as it is in the adult. The furca has attained the adult form. Of the swimming legs, the fourth pair is still very indistinctly segmented and the terminal claws are shorter than in the adult. The other pairs of legs are practically in the adult state.

Total length 4.3 mm.; length and width of carapace 2.7 mm.

Chalimus.—Carapace elliptical but markings as in adult except that the longitudinal grooves extend to the anterior margin. The eyes are not adjacent as they are in the adult. The posterior lobes of the genital segment have not yet appeared but the processes are already present and resemble those of the young female described above. The fourth segment is wider than the genital segment but without dorsal plates. The abdomen consists of only one segment and the setae of the caudal rami are as long as the abdomen and nonplumose.

All the appendages are quite immature in appearance. The claw of the second antenna is only slightly curved and quite short. The first maxillae are simple. The second maxillae are shorter and less slender and the terminal claws appear to be bifid at the tips. The basal portion of the furca is triangular and shorter than it is in later stages but the branches are much the

same as in the adult. The first legs are 3-segmented and the joints are shorter and broader; a rudimentary endopod is present in the form of a small 2-segmented process tipped with a single spine; the four terminal claws are present but the setae on the posterior border of the distal joint are as yet non-plumose. The second legs are still indistinctly segmented and the setae are non-plumose. The third exopod is 2-segmented, the endopod 1-segmented, with short non-plumose setae. The fourth legs are indistinctly 2-segmented, the distal segment armed with two lateral and two terminal spines.

Total length 2.5 mm.; length of carapace 1.6 mm.; width of same 1.3 mm.

Alebion carchariae Krøyer

Occurrence.—A few specimens on the outer surface of the dusky, bay and spot-tip ground sharks *(Carcharias obscurus, commersonii,* and *limbatus).*

Paralebion elongatus Wilson

Occurrence.—A few specimens in the mouth of the bay, dusky and spot-tip ground sharks.

Eirgos gen. nov.

Head fused with the first two thoracic segments; no lunules; third and fourth segments free, the former with a fused dorsal plate which extends beyond the fourth segment overlapping the anterior part of the genital segment; the latter is covered by a circular plate and surrounded, except posteriorly, by a pair of folds, bearing the rudimentary fifth legs at their posterior corners. The abdomen is reduced to very little more than a pair of caudal rami. First and fourth legs uniramose, the former 4- and the latter 3-segmented; second and third pairs biramose. Prehensile hook present; first maxillae bipartite; branches of furca simple.

Remarks.—Eirgos from εἴργω, to enclose, alluding to the folds enclosing the genital segment.

Eirgos anurus sp. nov.

Pl. 5, Figs. 112-124

Occurrence.—Several adult females and one immature female were found inside the mouth cavity of the spadefish *(Chaetodipterus faber).* The type female has received Cat. No. 69856, U.S.N.M.

Female.—Carapace orbicular, a little wider at its base than the length. Frontal plates large and without lunules. Two longitudinal grooves mark off a central area which comprises one-half of the width of the carapace; lateral areas divided by horizontal grooves into a small posterior area and an anterior one nearly twice its size. Posterior sinus wide and shallow. Third segment much narrowed but covered by a pair of fused dorsal plates which are nearly two-thirds the width of the carapace and which also completely cover the fourth segment as well as a small portion of the genital segment. These plates have a very slight sinus in their posterior margin indicating their origin from the fusion of a pair of plates although the young female shown in figure 124 shows no sinus at all. The genital segment, exclusive of the folds which al-

most completely encircle it, is circular in outline and is a little less broad than the dorsal plates of the third segment; it is completely covered by a circular plate, leaving the folds exposed. At the posterior corners of the latter three small setae occur, the rudimentary fifth feet, and indicate that these folds are to be regarded as belonging to the genital segment. The abdomen has been practically absorbed by the genital segment being reduced to little more than a pair of caudal rami which bear six setae, two of which, more dorsally situated, are plumose. Egg strings about the same width as the rudimentary abdomen and equal to the length of the animal.

The two joints of the first antennae are of equal length, the basal one setose. Second antennae 3-segmented with a strongly curved claw which bears a small accessory spine near its tip, giving it a bifid appearance; basal joint furnished posteriorly with a large spine. Prehensile hooks small and curved. Mouth tube conical, narrowed distally. Mandibles long and slender, distal joint curved with twelve rather blunt teeth on its inner border. First maxillae bifurcate but inner ramus very short; basal portion broadly triangular; palp represented by a small papilla bearing two spines, one of which is very small. Second maxillae slender with two apical claws, the inner one twice as long as the outer. Maxillipeds large with a strongly curved claw over half the length of the basal joint. Basal portion of furca a little longer than the rami which are simple, rounded distally and parallel, leaving a U-shaped sinus a little wider than each branch.

First and fourth legs uniramose, the second and third biramose. The first legs are 3-jointed; the basal joint bears a small spine at its anterior distal corner and a larger one on its posterior margin; the second segment also has a small spine at its anterior distal corner and the terminal joint is tipped with four claws and along the posterior margin bears three plumose setae. The basal portion of the second legs is 2-jointed, the second segment being very large and dilated; the rami are each 3-segmented, the basal joint of the exopod being slightly longer than the combined length of the two succeeding segments and bearing along its anterior border a fringe of long hairs. The rami of the third legs are 2-segmented and are set close together; the basal exopod segment bears a very large curved spine. These legs are attached to the outer border of a membranous flap, the second legs being attached to its anterior border. This membrane is divided by a horizontal groove, marking the division between the second and third segments, the position of which coincides with that of the anterior border of the dorsal plates which cover the third segment. Fourth legs 3-segmented; basal segment dilated and as long as the two terminal joints together, with a short spine at its outer distal corner; distal segment with four claws, one lateral and three terminal, the bases of the latter being covered by small membranes.

Total length 2.8 mm.; length of carapace 1.4 mm.; width of same 1.8 mm.

Immature female.—This specimen is of especial interest for it shows the abdomen before it is absorbed by the genital segment when the two are equal in size. At this time the combined length of the abdomen and the genital segment is equal to the length of the genital segment of the adult female and

suggests that the abdomen of the latter disappears by the obliteration of the segmentation between these two parts and the subsequent migration of the oviducts into the abdominal region. Except that the carapace is larger, this immature specimen is similar to the adult form.

Total length 2.4 mm.; length of carapace 1.6 mm.; width of same 1.7 mm.

Remarks.—With the discovery of this genus, we have a second example of a Caligid in which the first two thoracic segments are fused with the head as in the genus *Trebius*. In the *Caliginae* and *Euryphorinae* three thoracic segments and in the *Pandarinae* and *Cecropinae* one thoracic segment are fused with the head. *Trebius* forms a link between the *Caliginae* and the *Euryphorinae* and the present genus serves a similar purpose between the *Trebinae* and the *Euryphorinae* and *Pandarinae*. Like *Gloiopotes*, one of the *Euryphorinae*, this new genus lacks lunules but both have bipartite maxillae and their thoracic legs are similarly constructed. In *Gloiopotes* we find a single pair of dorsal plates on the fourth segment whereas in *Eirgos anurus* there is a pair on the third segment, none on the fourth segment and a single plate on the genital segment, a condition which more closely resembles that found in the *Pandarinae* or *Cecropinae*. The male will have to be found before this genus can be finally assigned to its proper place amongst the subfamilies of the family *Caligidae*.

Pandaridae

Perissopus communis Rathbun

Occurrence.—Sparingly on the body of the bay, dusky, shovelhead, sharp-nosed and smooth-toothed sharks.

Pandarus satyrus Dana

Occurrence.—A few specimens on the outer surface of the dusky shark.

Pandarus sinuatus Say

Occurrence.—Found in limited numbers on the body of the dusky and shovelhead sharks.

Pandarus smithii Rathbun

Occurrence.—A few specimens found only on the dusky shark.

Nesippus alatus Wilson

Occurrence.—Fairly common in the mouth and on the outer surface of the bay, dusky and spot-tip ground sharks.

Nesippus gracilis Wilson

Occurrence.—Fairly common in the mouth and on the body of the bay, dusky and spot-tip ground sharks.

Entepherus gen. nov.

Female.—Head fused with first segment, carapace wider than long; second and third segments distinct, the former with large serrate lateral plates, the

latter with fused median dorsal plates; fourth segment with large fused median dorsal plates covering the anterior portion of the genital segment, with a narrow median sinus, their margins serrate. Genital segment with a pair of horny processes and completely covered by fused dorsal plates with serrate margins and a very shallow sinus. Abdomen attached to ventral surface of genital segment and completely hidden by it; caudal rami large and foliaceous. Rami of first three pairs of legs 2-segmented, of fourth pair 1-segmented; basipods of second and third pairs united by a median lobe. No fifth legs. Ἔντεα, a coat of mail, and φέρειν, to bear.

Male.—Carapace broader posteriorly than that of female, with large lobes; lateral lobes of second segment not serrated; fourth segment plates much smaller than in females, only slightly overlapping genital segment which has a pair of horny processes and is covered by a circular plate. Abdomen 2-segmented; caudal rami large, each with four plumose setae. Rami of first three pairs of legs 2-segmented, of fourth pair 1-segmented, the latter only foliaceous.

Entepherus laminipes sp. nov.

Pl. 7, Figs. 156-173

Occurrence.—Many specimens, including a few males, were taken from the sieve-like gill rakers of the devilfish (probably *Mobula hypostoma).* The majority of the copepods were themselves heavily covered with a colonial coelenterate *(Obelia* sp.). Type male and female Cat. No. 69837, U.S.N.M.

Female.—Carapace semicircular in outline, considerably wider at the base than the length, divided by two longitudinal grooves into a large central area and two smaller lateral ones; no subdivision of the lateral areas was noted. The frontal plates are fused with the carapace but indicated in outline. The second and third segments are narrower than the central portion of the carapace; the second segment bears a pair of large lateral plates which are joined across the dorsal surface and the third segment is almost entirely covered by a pair of completely fused dorsal plates. The fourth segment is considerably narrowed and bears a large pair of dorsal plates which partially overlap the genital segment; the narrow sinus separating these plates extends about three-quarters of the distance to the anterior border. Except for a pair of horny processes attached to the posterior corners the genital segment is completely hidden by a fourth pair of dorsal plates which slightly overlap it and are more nearly fused than the preceding pair, only a very slight sinus remaining. The margin of both these pairs of dorsal plates is serrate, the third pair much more finely toothed than the second. The 1-jointed abdomen is invisible in dorsal view, being attached to the ventral surface of the genital segment. The caudal rami are very large, almost circular in outline and armed with three terminal and two lateral spines in addition to minute spinules along the inner and terminal margins. The egg strings form a tightly coiled mass carried between the abdomen and genital segment and are almost completely concealed by the dorsal plates of the latter.

First antennae 2-segmented, the joints of about equal length; the basal one is armed with short spines while the terminal one, which is much narrower, is

tipped with a number of short setae. Second antennae 3-segmented with a strongly curved claw; the terminal joint has a short spine half way along its inner margin and a smaller one at its base. The mouth tube is long, narrow and conical in shape. Mandibles slender, the end slightly curved with twelve bluntly pointed teeth. The first maxillae, which lie at an angle to the mouth tube and are about one-third its length, are cylindrical in shape bearing distally a blunt spine. Second maxillae 2-jointed, the second one slender and terminating in a short curved claw, at the base of which is a shorter spine covered with small spinules; on the opposite surface is a round knob which is also covered with spinules. Maxillipeds very large, the terminal joint with a strongly curved claw and a small accessory spine on its inner margin; the ventral surface of the basal joint bears two rounded knobs opposite each other, one of which is tipped with two small spines.

The four pairs of legs are biramose and lamellar in form; the rami of the first three pairs are 2-segmented, those of the fourth pair 1-segmented. The rami of the first pair are about equal in size, as are those of the fourth pair but the exopods of the second and third pairs are much smaller than the endopods. The third and fourth pairs are sparsely provided with spines but have minute spinules along the terminal and outer margins, while the terminal joints of the first and second pairs have a goodly number of spines. The larger spines of these two pairs of legs are themselves bordered with very small spinules. A median lobe unites the basipods of the second and third legs.

Total length 7.7 mm.; length of carapace 3.7 mm.; width of same through widest part 5 mm.

Male.—Like that of the female, the carapace is semicircular in outline but although the same length is much wider at its base. In addition to the longitudinal grooves there is an indistinctly marked oblique groove in the lateral areas. The posterior margin of the carapace is armed with three patches of spinules. The second and third segments are about one-quarter the width of the carapace; the former carries a pair of large lateral plates while the latter is almost entirely covered by a dorsal plate. The dorsal plates of the fourth segment are about one-half the size of those of the female and barely overlap the base of the genital segment, but like those the margin is coarsely toothed; the sinus between these plates is very wide and shallow. The genital segment is almost circular with convex sides and from its lateral margins project a pair of horny processes as in the female; it is completely covered by a dorsal plate which slightly overlaps the abdomen, the latter being 2-segmented with large caudal rami similar to those of the female except that there are four long plumose setae and an outer short spine.

Unlike the female, except for the fourth pair, the legs are not foliaceous. The endopod of the first pair is about two-thirds the length of the exopod; the rami of the remaining legs are of equal length and are all armed with plumose setae and spines. The basipods of all except the first pair of legs are large and the second and third legs are united by median lobes as in the female.

The antennae and mouth parts are very similar to those of the female.

Total length 9.8 mm.; length of carapace 3.8 mm.; width of same 7 mm.

Remarks.—The species which has just been described has points in common with *Cecrops, Orthagoriscicola* and *Philorthragoriscus,* all members of the subfamily *Cecropinae,* but in general appearance it resembles *Philorthragoriscus.* Like *Cecrops,* it has three pairs of dorsal plates, one each on the third, fourth and genital segments, in addition to a pair of lateral plates borne by the second segment, which are joined by a narrow band across the dorsal surface. *Orthagoriscicola* and *Philorthragoriscus* have but two pairs of fused dorsal plates. As in these two genera, the margin of the third and fourth pairs of dorsal plates is serrate, not as coarsely toothed as in the former but similar to that of *Philorthragoriscus.* The abdomen is considerably smaller than the genital segment as in the latter genus and is also without the lateral lobes or laminae which are connected with the abdomen of both *Cecrops* and *Orthagoriscicola.* However, although lacking these lobes the egg strings are nevertheless coiled in a mass and carried bettween the abdomen and genital segment. In *Philorthragoriscus* where the abdomen is without lateral lobes, the egg strings are uncoiled as in *Caligidae* in general.

The second maxillae very closely resemble those of *Philorthragoriscus,* which are somewhat different in structure from this appendage in the other two genera. The remaining mouth parts are in general agreement with those of the subfamily.

Except for the third and fourth legs of *Orthagoriscicola,* the swimming legs of the three genera under discussion do not approach the laminate condition of the present material. However, the segmentation of the rami is similar to that of *Cecrops* and *Philorthragoriscus.*

The possession by the made of dorsal plates on the thorax and genital segments affords additional evidence of the relationship of this new genus with the members of the subfamily *Cecropinae.*

Anthosomidae

Lernanthropus brevoortiae Rathbun

Occurrence.—A few found on the gills of the menhaden.

Lernanthropus caudatus Wilson

Occurrence.—Found in limited numbers on the gills of the sheepshead.

Lernanthropus chlamydotus Wilson

Occurrence.—A few specimens only were found on the gills of the needlefish *(Strongylura notata* and *S. timucu).*

Lernanthropus pomatomi Rathbun

Occurrence.—Found in abundance on the gills of the bluefish but no males were observed.

Lernanthropus rathbuni Wilson

Occurrence.—Found sparingly on the gills of the original host, the hogfish.

Lernanthropus spiculatus Wilson

Occurrence.—A few specimens on the gills of the spot or lane snapper *(Lutianus synagris)*.

Lernanthropus krøyeri van Beneden

Pl. 11, Fig. 254

Occurrence.—About half a dozen specimens on the mangrove snapper *(Lutianus griseus)*.

Lernanthropus pupa Burmeister

Pl. 9, Figs. 216-232

Lernanthropus pupa Burmeister, Acta Acad. Caes. Leop. Carol. Nat. Cur., vol. 17, p. 303, pl. 24, figs. 7-11, 1833.

Occurrence.—A large number of specimens, including one male, were obtained from the gills of the spadefish *(Chaetodipterus faber)* and constitutes the first record of this species from American waters. One female, Cat. No. 69842 U.S.N.M.

Female.—General body form oblong, about three times as long as wide. In dorsal view the cephalothorax appears slightly narrowed anteriorly; lateral flaps broad, divided by a narrow horizontal sinus near the anterior end. Dorsal plate same width throughout, the anterior portion constituting one-third of its length, evenly rounded posteriorly and extending beyond the caudal rami and fourth legs. Genital segment a little wider than long with convex lateral margins; abdomen 1-segmented, half the width of the genital segment; caudal rami over twice as long as wide, the distal third narrowed to a point. Egg strings project but a short distance beyond the dorsal plate.

First antennae 6-jointed, with few setae. Terminal claw of second antennae with a blunt spine. Mouth tube small, conical. Endopod of first maxillae short, almost spherical, tipped with two blunt spines; exopod long and narrowing distally, terminating in two blunt spines, the longer one curved. Claw of second maxillae slender, almost as long as the basal joint, margins of distal portion armed with fine teeth. Claw of maxillipeds straight almost to the tip, the basal joint with a short spine half way along its inner margin.

First leg placed close behind the maxillipeds; endopod elongate with a long apical spine and sparsely covered with minute spines; exopod laminate, tipped with five short spines; inside the endopod is a short spine and outside the exopod is a small 2-segmented papilla bearing a slender seta. Second legs smaller, endopod bearing minute spines but without terminal seta and exopod with only four spines; papilla outside exopod is also 2-jointed. Third legs of the usual pattern. Fourth legs divided nearly to the base, rami long and slender, tapering to a fine point.

Total length 5:6 mm.

Male.—Cephalothorax nearly half the entire length, slightly wider than body, antennal area narrowed and projecting. Body nearly twice as long as

wide, narrow posteriorly; abdomen less than a third the width of the thorax; caudal rami large, 3-jointed, distal segment small and bearing two spines.

First antennae 7-segmented. Bases of second antennae united, each armed along inner margin with four stout spines. First maxillae much like those of female but exopod terminates in three acuminate spines. The teeth of the second maxilla claw are coarser than those of the female and it is provided with two accessory spines. Maxilliped similar to female but posterior portion of basal joint covered with minute spines on the ventral surface.

The first legs differ somewhat from those of the female; the exopod is armed with only four spines and these are shorter and blunt; endopod armed with many minute spines and the long slender spine of the female is replaced by two narrow segments, the second one divided distally into three parts and rough in appearance. The second legs also differ, the exopod being 2-segmented, longer and narrower; the endopod bears an apical, 3-jointed seta. Third and fourth legs biramose, the endopod of the former much shorter than the exopod; that of the fourth legs only slightly shorter than the exopod.

Total length 1.8 mm.; width .62 mm.

Color.—Animal suffused with blood and therefore red in color; egg strings brown.

Lernanthropus gisleri van Beneden

Pl. 10, Figs. 233-247

Lernanthropus gisleri van Beneden, Bull. Acad. Roy. Belgique, vol. 19, p. 102, figs. 1-6, 1852.

Occurrence.—Found in abundance on the gills of the snook *(Centropomus undecimalis)* and less so on the gills of the spotted sea trout *(Cynoscion nebulosus)*.

Female.—Cephalothorax subquadrangular in dorsal view, folded down along the anterior and lateral margins leaving a triangular sinus in which the antennae lie. Dorsal plate elongate, same width as head anteriorly, wider just below the third legs and then narrowing again to form a rounded median lobe, leaving the abdomen exposed. Genital segment widened through the middle and tapering posteriorly to the width of the abdomen. Caudal rami long and narrow.

First antennae small, invisible in dorsal view, 6-segmented, the basal joint greatly enlarged, distal segment tipped with a number of setae. Arising at the base of this antenna is a 2-segmented appendage, the basal joint of which is thickly covered with fine hairs and which is shorter and much broader than the distal segment which is slender and slightly curved. A similar structure is present in *Lernanthropus krøyeri* and is probably analogous to the prehensile hook of the *Caligidae*. Second antennae 2-segmented, the basal joints united; terminal claw stout and curved. Mandibles 3-jointed, slender, forming six sharp teeth distally. First maxillae small with two palp-like rami, the inner one tipped with a stout spine and half the length of the outer, which has two apical spines. Second maxillae of usual pattern, terminal claw with a row of

short teeth along each margin and a rather stout spine a little below its base. Maxillipeds 2-segmented, terminal claw jointed about one-third from the tip.

Exopod of first legs elongate with four moderately long terminal spines and a shorter inner one; endopod triangular, bluntly pointed, unarmed. Second legs smaller, exopod with three terminal spines, endopod of irregular shape without spines. In dorsal view the third legs stand out at right angles to the dorsal plate; they are folded in the usual manner but are narrower than in most species. Fourth legs fully as long as the body only their bases covered by the dorsal plate, divided almost to the base, rami quite slender tapering to a blunt point. Fifth legs long and quite slender arising just anterior to the genital segment and extending beyond the caudal rami.

Total length, including caudal rami, 3.9-5.2 mm.; width 1.5-2.0 mm.

Male.—Cephalothorax 6-sided, the antennal area a little narrower than the body but flaring out from this point to one and a half times the width of the body, the posterior margin being convexly rounded. Body twice as long as wide, abdomen very small with slender caudal rami.

First antennae 7-segmented, the two basal segments wider than the others, the distal segment armed with a number of setae. Distal segment of prehensile hook longer than in female but basal segment smaller and less profusely armed with setae. Mouth parts much like those of female but the inner margin of the maxillipeds armed with very small spines.

The first legs differ from those of the female in the endopod possessing an apical spine and being armed with minute spines. The endopod of the second legs is also covered with spines and bears a terminal spine; the exopod is armed with a row of small spines along its terminal margin, anterior to which arise four moderate sized spines. Third legs very short, inner ramus half as long as the outer. Fourth legs nearly as long as body, rami of equal length.

Total length (to base of caudal rami) 2.6 mm.; width of cephalothorax 1 mm.

Remarks.—Although this species has been known since 1852 and has been reported from Europe on various occasions, the present material constitutes the first record from American waters, and a single female has been deposited in the National Museum with Cat. No. 69843.

Lernanthropus longipes Wilson

Pl. 10, Figs. 248-253

Lernanthropus longipes Wilson, Bull. 158, U. S. Nat. Mus., p. 448, pl. 28, 1932.

Occurrence.—A number of females were obtained from the gills of the black drum *(Pogonias cromis)*, the original host, in addition to a single male and female from the gills of the banded drum *(Larimus fasciatus)*, which have been given Cat. No. 69857 U.S.N.M.

Male.—Cephalothorax longer than wide, antennal area narrowed and leaving a triangular notch in which the first antennae lie. Second and third segments narrower than cephalothorax, their boundaries indicated by lateral

invaginations and distinct dorsal grooves. Remainder of body unsegmented, narrowed below the fourth legs; abdomen small and nearly square; caudal rami long and narrow tapering to a point.

First antennae 7-segmented, the basal segment broader and longer than the others, all with one or two setae. Second antennae like those of female. The second maxillae differ from those of the female in having the distal portion of the claw armed with two rows of fine teeth. Maxillipeds also resemble those of the female.

Endopod of first and second legs conical and partially covered with minute spines; both terminate in a long seta, the distal half of which is armed with tiny spines. The first exopod broadens out towards the terminal margin, along which are five stout spines; the second exopod of rather irregular shape, has a number of small spines on the distal margin and three or four larger ones just above them. Unlike the female the third legs are very short, the inner ramus a little shorter than the outer; the fourth legs are longer than the whole body, both rami of the same length.

Total length 3 mm., including fourth legs 6.1 mm.; width of cephalothorax 1.0 mm.

Color.—Head light red; remainder of body including the legs a horny color; a dark red streak down the middle of the body.

Remarks.—The female of this species was described by Wilson in 1932 in the above reference. The male resembles the female in the segmented character of the thorax and the exceptional length of the fourth legs.

Lernanthropodes gen. nov.

Female.—Head fused with first segment, carapace margins turned down ventrally; thoracic segments fused. Genital segment and abdomen each 1-segmented, the latter with a pair of caudal rami. Second antennae and maxillipeds prehensile and uncinate; first four pairs of legs biramose; first two pairs rudimentary with 1-segmented rami; endopods of third pair fused along their inner margins, the exopods free but directed upwards and dorsally slightly overlapping along the mid-dorsal line, extending backwards and forming a cylinder enclosing the genital segment, abdomen and fourth legs; the rami of the latter lamellar, separate nearly their whole length; fifth legs not present.

Lernanthropodes cucullus sp. nov.

Pl. 11, Figs. 255-265

Occurrence.—A few females were found on the gills of the pompano *(Trachinotus carolinus)* and the permit *(T. falcatus)*. Type female Cat. No. 69844 U.S.N.M.

Female.—The cephalothorax, in dorsal view, is a little longer than wide and at its base is slightly wider than the body; the lateral portions of the cephalothorax are broad and bent down ventrally; the posterior border of the carapace is concave. The body is in the form of a narrow cylinder protruding slightly where the second legs are attached and a little less narrow at the pos-

terior end. The genital segment is roughly spindleshaped; the one-jointed abdomen slightly narrower and quadrangular with a very minute sinus in the posterior margin. The caudal rami are longer than the abdomen, narrowed distally and without setae or spines. The egg strings vary in length, in some specimens being longer than the entire animal.

The first antennae are very small, 7-segmented, tapered towards the distal end and provided with but few short setae. The second antennae are 2-jointed, the basal joint large, the terminal in the form of a curved claw. The mouth tube is conical, bluntly rounded at the tip. The mandibles are slender with seven sharp, curved teeth on the inner distal margin. The first maxillae, adjacent to the mouth tube, have a rather large base to which are attached two elliptical rami, the inner of which is smaller and tipped with a single seta, the outer one bearing three setae. The second maxillae have a wide basal portion; the terminal joint is slender and bears a short nearly straight claw which is armed with a row of fine teeth along the margins. The basal joint of the maxillipeds is large and the terminal claw strongly curved.

The first two pairs of legs are biramose with 1-jointed rami; the exopod of the first pair is nearly circular, that of the second almost square but each is provided with five stout spines; the endopod of both pairs is tipped with a long slender spine; outside the first exopod is a slender seta and inside the endopod is a short spine; the seta on the outside of the second exopod is longer and arises from a rather broad basal segment. The greatly modified third legs are fully as long as the body and the rami are fused for almost their entire length; the inner margins of the endopods are united for an almost equal distance, while the free exopods curve upwards and slightly overlap along the median dorsal line, forming thus a cylindrical enclosure, continuous with the body, inside of which are found the genital segment, the abdomen and the fourth legs. The latter are less than two-thirds the length of the third pair and each is composed of two rami united anteriorly for one-quarter of their length; the rami are slender and taper to a blunt point.

Total length 4.9-7.5 mm.; width 1 mm.

Color.—Head and anterior half of the body red, remainder light brown with red tinge.

Remarks.—The specific name, which means a covering of the feet, calls attention to the envelopment of the genital segment, abdomen and fourth legs by the third pair of legs.

While closely agreeing with the genus *Lernanthropus* in general body form and the structure of the appendages, the peculiar modification of the third pair of legs seems to warrant the creation of a new genus for this species. In *Lernanthropus* the third legs are entirely separate from one another and project at right angles or obliquely from the ventral surface of the body. The condition of the third pair of legs in *Lernanthropodes* can be imagined as resulting from the lengthening and flattening of the two laminae of *Lernanthropus* with fusion along their inner margins.

Eudactylinidae

Krøyeria gracilis Wilson

Occurrence.—Found in abundance on the gills of the bay *(Carcharias commersoni)*, the hammerhead *(Sphyrna zygnea)*, the smooth-toothed *(Aprionodon isodon)* and the spot-tip ground *(Carcharias limbatus)* sharks.

Nemesis pallida Wilson

Occurrence.—Found commonly on the gills of the dusky *(Carcharias obscurus)*, bay, hammerhead, sharpnosed *(Scoliodon terra-novae)*, shovelhead, smooth-toothed and spot-tip ground sharks.

Eudactylina spinifera Wilson

Occurrence.—A few specimens on the gills of the dusky shark.

Remarks.—The spine-like character of the endopod of the fourth pair of legs readily differentiates this species from the four others occurring in this region.

Eudactylina aspera Heller
Pl. 8, Figs. 185-196

Eudactylina aspera Heller, Reise der Novara, Zool. Theil, Bd. 2, Ab. 3, p. 213, pl. 21, fig. 1, 1865.

Occurrence.—A few females were found on the gills of the sharp-nosed and smooth-toothed sharks.

Female.—Head as wide as long, rounded anteriorly, posterior margin slightly concave, lateral margins notched anteriorly. First three thoracic segments wider than long, each one a little longer than the preceding and covered almost completely by a spiny dorsal carapace; fifth segment almost circular and not as completely covered by the dorsal carapace; genital segment almost square in outline, about half as wide as the fifth segment; abdomen 2-segmented, both much wider than long with the caudal rami arising about half way along the lateral margin of the anal segment which is narrowed at this point and bilobed posteriorly; caudal rami with two apical and one outer spine.

First antennae 7-segmented, well supplied with spines and setae. Second antennae 3-segmented with a strongly curved claw and one large and two small accessory spines, second segment with a very large spine on the inner margin and almost completely covered with a plate which is armed with short but stout spines; basal segment with a stout spine on its inner margin.

Both segments of the second maxillae covered with spines and near the base of the apical claw there is a tuft of short setae; the claw itself gives off a short spine near its distal point and at its base there arises a transparent pectinate membrane or flange about half its length. Maxillipeds of usual type.

The first, third and fourth legs have 3-segmented rami, the outer margins of which are armed with spines; the second endopod is also 3-jointed and similar to those of the other legs but the exopod is quite distinctive, the basal segment being longer than the entire endopod and decidedly curved and is followed by three short joints, the penultimate one bearing a long and short

seta. The fifth legs are sparsely covered with short spines and tipped with three setae.

Total length 1.1 mm.; width .31 mm.; egg strings .6 mm. long.

The color of living specimens was creamy with a greyish tinge.

Remarks.—This species, which has not been reported since its original description by Heller, has a number of distinguishing features—the structure of the second legs, the notch on the side of the head, and the origin of the caudal rami on the lateral margin of the abdomen.

A single larger specimen (1.56 mm. long) of what is regarded as this species was taken from the gills of the smooth-toothed shark. The appendages of this individual are in complete agreement with those just described but the abdomen and caudal rami are very different. The basal abdominal segment is square, the anal segment one-third as long and narrower; the caudal rami which are as long as the basal segment and arise in the normal manner are 2-jointed, the terminal segment being very small. In addition to these differences, there is present on the mid-ventral line, posterior to the base of the second legs, a moderately large spine (Figs. 195 and 196).

Until more specimens of *Eudactylina* can be collected from the smooth-toothed shark it is deemed advisable to regard this specimen as an aberrant example of *E. aspera* rather than create a new species for it. A single female from the sharp-nosed shark has been given Cat. No. 69838, U.S.N.M.

Eudactylina longispina sp. nov.

Pl. 7, Figs. 174-184

Occurrence.—A very few specimens found on the gills of the shovelhead shark *(Reniceps tiburo)*. Type female Cat. No. 69839, U.S.N.M.

Female.—Cephalothorax elliptical; the first two free thoracic segments wider than long, the second wider than the first, the fourth segment twice as long as the preceding one and slightly wider, the fifth narrower but about the same length as the third segment; genital segment half the length and width of the fifth segment; abdomen covered with spines, narrower than the genital segment, its two segments about the same length; caudal rami longer than the anal segment, each tipped with two setae and also covered with small spines.

First antennae 6-segmented, not heavily armed and without the large spiny claws typical of the genus; basal segment much longer and a little wider than the next two which are of about equal length; the three terminal segments small and about the same size. Second antennae 4-segmented, the third segment somewhat swollen and armed on its inner margin with two spines; apical claw of distal segment large and provided with three large accessory spines.

Mandibles long and narrow with three of four minute teeth. First maxillae tipped with one long inner seta and an outer short one. Second maxillae 2-segmented, both covered with short spines; terminal claw pectinate. Maxillipeds chelate, with two spines on the inner margin of the movable digit.

Rami of first legs of equal length and both 2-segmented, basal segment

of exopod with a row of short teeth on the outer margin, distal segment tipped with two setae. Exopods of second and third legs 3-segmented, the basal segments of both longer than the next two which are armed with long setae; endopod of former 1-segmented covered with short spines and bearing a long apical seta; endopod of the latter 2-segmented, tapering and terminating in a single long seta. Both rami of the fourth legs 3-segmented, the distal endopod segment seta-like, very slender and twice as long as the combined basal segments. Fifth legs uniramose, covered with short spines and tipped with two setae.

Total length 1.0 mm.; width of fourth segment .23 mm.

Color.—Entire body light creamy.

Remarks.—This species can be readily identified by its fourth pair of legs with their long, seta-like endopod.

Eudactylina turgipes sp. nov.

Pl. 8, Figs. 197-206

Occurrence.—Found sparingly on the gills of the butterfly ray *(Pteroplatea maclura)*. Type female Cat. No. 69840, U.S.N.M.

Female.—Cephalothorax entirely covered with small spines, longer than wide, rounded anteriorly and widening towards the posterior margin which is slightly emarginate. Second segment wider than head but slightly narrower and shorter than the third segment which is the same width and more than half the length of the fourth segment; fifth segment equal in length and width to the third segment. Each of these segments bears a dorsal carapace which is thickly covered with short spines. Genital segment shorter and about half the width of the fifth segment. Abdomen slightly narrower and shorter than the genital segment, anal segment somewhat shorter than basal, caudal rami bearing two terminal setae and two on the outer margin.

First antennae 5-segmented and well armed with claws and setae. The two basal segments of the second antennae about the same size, the first with two small spines on the inner margin, the second with one very large and one small spine; apical claw long and curved, reinforced by three accessory spines.

Basal segment of second maxillae partially covered with spines, terminal segment armed with blunt spines on outer margin and a tuft of short spines at the base of the apical claw which is bifid. Maxillipeds provided with two spines on the inner margin and a seta on the outer margin of the movable digit.

Both rami of first legs 2-segmented and covered with spines; inner margin of basal endopod segment armed with a row of teeth, distal segment long and narrow with two apical setae, exopod terminating in a very long seta. Rami of remainder of legs all 3-segmented and except for the endopod of the second legs bear long apical setae; the second endopod is much swollen, the two distal segments more or less coalesced and armed with short curved claws. Fifth legs narrowed posteriorly, truncate and tipped with two apical setae.

Total length 1.6 mm.; width .31 mm.

Color.—Creamy with greyish tinge to the head.

Remarks.—The peculiar swollen condition of the second endopod (hence named *turgipes),* resembling somewhat a hand with short curved digits, and the long first endopod will serve to differentiate this species from other *Eudactylina.*

Eudactylina squamosa sp. nov.

Pl. 8, Figs. 207-208, Pl. 9, Figs. 209-215

Occurrence.—Found sparingly on the gills of the cow-nosed ray *(Rhinoptera bonasus).* Type female Cat. No. 69841, U.S.N.M.

Female.—Cephalothorax covered with spines, narrowed anteriorly but evenly rounded, posterior margin concave. Second, third and fourth segments about the same width but increasing in length; fifth segment slightly narrower and as long as the third segment; genital segment narrower and shorter than the fifth segment; all five segments partially, the third one almost completely, covered with a spiny dorsal carapace. The two abdominal segments of equal length, narrower than the genital segment; caudal rami slightly inclined towards each other, tipped with a short spine and covered with minute spines.

First antennae 5-segmented, not as well armed as those of *E. turgipes,* the second and third segments together bearing three large claws. Middle segment of second antennae with two stout spines on inner margin, apical claw with only a single very small accessory spine.

Distal segment of second maxilla covered with large scalelike spines. Maxillipeds of usual pattern, bearing four spines on distal portion of movable digit and one on outer margin.

Rami of first four pairs of legs 3-segmented and all except the second exopod armed with spines on the outer margins. Basipod of first legs produced into a short lobe. The second legs resemble somewhat those of *E. spinifera* but the exopod is much shorter than the endopod and bears a spine at its outer posterior and anterior corners; the terminal segment bears two short apical spines. The third and fourth legs are similar; fifth legs uniramose, the posterior margin scalloped and tipped with two setae.

Total length 1.4 mm.; width 2.8 mm.

Remarks.—The distinguishing characters of this species are not as striking as for the two other new species in this region but the structure of the modified second legs and the large scale-like spines on the second maxillae constitute the most important differences.

Eudactylinella alba Wilson

Occurrence.—Found in small numbers on the gills of the whip stingray *(Dasyatis hastatus).*

Pseudocycnidae

Pseudocycnus buccatus Wilson

Occurrence.—Very abundant on the gills of the Spanish mackerel *(Scomberomorus maculatus).*

Dichelesthiidae

Hatschekia oblonga Wilson

Occurrence.—The gills of nearly all the specimens of spiny toadfish were found to be infested with this copepod.

Lernaeidae

Lernaeenicus longiventris Wilson

Occurrence.—Embedded near the base of the tail, and lying between the caudal rays, of the mullet and bluefish. A few specimens only.

Chondracanthidae

Pseudochondracanthus diceraus Wilson

Occurrence.—A few specimens found on the gills of the rabbitfish *(Lagocephalus laevigatus)*, the northern swellfish *(Spheroides maculatus)* and the Florida swellfish *(S. nephelus)*

Triphyllacanthus ancoralis sp. nov.

Pl. 11, figs. 266-283

Occurrence.—Found sparingly on the gills of the batfish *(Ogcocephalus* sp.). Type female Cat. No. 69845, U.S.N.M.

Female.—Anterior half of head covered by a dorsal carapace, with a pair of lateral semicircular lobes; the posterior part is shorter and greatly dilated ventrally so that the mouth parts project considerably. The first thoracic segment is very short, about the same width as the head and bears the first pair of legs. Trunk a little broader and about two and one-half times as long as the head and there is some indication that it is composed of three segments but the dorsal grooves are indistinct; posteriorly it is produced into very small lobes. The genital segment is small, wider than long. The abdomen is 1-segmented, about equal in length to the genital segment but much narrower, although the posterior half is somewhat swollen and gives rise ventrally to the upwardly curved caudal rami, each bearing a very small terminal spine. The egg strings are about one-third the width of the trunk and fully as long as the whole animal.

The first antennae are unsegmented, the distal half narrowed and turned downwards. The second antennae are composed of two parts—a dark brown, narrow stem-like portion extending anteriorly and, surrounding its expanded end, a large colorless transparent, rather thick structure which is divided into two lobes by a narrow sinus; the latter part of the appendage is completely embedded in the gill filament, the stem alone being visible.

The mandibles conform to the chondracanthid type, the blunt teeth of the anterior margin being smaller than those on the posterior. The single papilla comprising the first maxilla bears two setae. The two segments of the second maxillae are of equal length, the terminal in the form of a slightly curved claw. the distal half of its posterior border with curved, acuminate teeth. Maxillipeds 3-segmented, the terminal claw short and almost straight.

There are two pairs of biramose legs, the endopod of both slightly shorter

and about half the width of the exopod, the latter only being marked off from the basipod; the margins of both legs are armed with very minute spinules.

Total length, including second antenna, 3.2 mm.; width of trunk .8 mm.; length of egg strings 3 mm.

Color.—Body dark grey, the first antennae and abdomen a lighter shade.

Remarks.—Three young females without egg strings, ranging in length from 2.65 mm. to 3.45 mm., were obtained in the spring. In the smallest of these specimens (Figs. 274 and 275) the head, genital segment and abdomen are relatively larger than in the adult form and the trunk is less flattened dorso-ventrally and is the same diameter throughout.

Male.—Head semicircular in outline and followed by the rapidly tapering trunk which is 5-segmented, the first two of which carry the rudimentary legs. The caudal rami, twice as long as wide, are bifid at their tips.

The first antennae are composed of three joints of equal length and width, the distal one armed with a number of setae. The basal joint of the second antenna is large, triangular and bears a stout spine half way along its outer margin; the terminal uncinate claw is half as long as the joint. Second maxillae without teeth but otherwise similar to those of the female, as are also the maxillipeds. The two pairs of legs are uniramose each bearing two apical setae.

Total length .3 mm.

Immature specimen (Fig. 281).—In the spring a single immature specimen, measuring 1.7 mm. was obtained from the gills of the same host. In dorsal view the head is subquadrangular and is followed by a 5-segmented tapering trunk, the first two wider than long, the next three longer than wide. Posteriorly the head is a little wider than the trunk. The caudal rami are acuminate.

First antennae 5-segmented, the terminal joint bearing a number of setae. Second antennae 2-segmented, the basal joint short and broad, the distal in the form of a sickle-shaped claw.

The size of this specimen shows that it must be a female but the form of the body and the uncinate character of the second antennae are very suggestive of the adult male.

Remarks.—In a review of the family *Chondracanthidae,* Oakley (1930) established the genus *Triphyllacanthus* for Heller's species *Trichthacerus molestus,* at the same time rejecting the latter genus, created by Krøyer in 1863 for *Trichthacerus persistedii,* from the family. The greatly modified second antennae of the present material place it in this new genus, *Triphyllacanthus.* This generic name, however, is an unfortunate choice as the second antennae of *T. ancoralis* are not tripartite and, therefore, if this new species is to be retained in the genus Oakley's definition of the genus, which was based entirely upon the species *T. molestus,* will have to be broadened as it is much too limited in scope.

Lernaeopodidae

Naobranchia lize (Krøyer)

Occurrence.—Found in abundance on only a few of the mullet examined.

Naobranchia variabilis Brian

Pl. 12, Figs. 304-313

Naobranchia variabilis Brian, Bull. d'Etud. hist. et sci. d'Afrique, July-Sept., 1924, p. 57; figs. 60-65.

Occurrence.—Found in limited numbers on the gills of the squirrelfish *(Diplectrum formosus)*, the foolfish *(Ceratacanthus schoepfii)*, the spiny toadfish *(Chilomycterus spinosus)* and the batfish *(Ogcocephalus* sp.). Brian's specimens were obtained from the rabbitfish *(Lagocephalus laevigatus)* on the Atlantic coast of Morocco (ancient Mauritania).

Female.—Cephalothorax shorter than trunk, head marked off by a dorsal grove, without dorsal carapace; neck separated from trunk by two broad ridges; trunk narrowed posteriorly and completely surrounded by the egg strings, the ribs of their enclosing membrane forming a rather elaborate pattern.

First antennae 3-segmented, the basal segment longer and broader than the other two; second segment with a short seta at the outer distal corner, the third segment with a single apical seta. Second antennae biramose, rami 1-jointed, the endopod with a single short apical spine. First maxillae simple with two long setae but no palp; second maxillae of usual type. Basal segment of maxillipeds with a notch in the anterior margin into which the terminal claw shuts down, the latter with an accessory spine.

Length of trunk 1.7 mm.; width, including egg strings, 2 mm.

Male (Fig. 309).—Body unsegmented, trunk arched dorsally with the posterior portion turned forwards; no caudal rami.

First antennae 4-segmented, the second segment very short; the two last segments each with a single rather blunt spine. Second antennae biramose; exopod 2-segmented each bearing a single spine; endopod 1-segmented tipped with two short spines. Basal segment of second maxillae large with a small process near the distal end which is armed with four or five short spines; terminal claw curved and rather blunt. Basal maxilliped segment broad with two knobs, the anterior one covered with short spines, the posterior bearing two short setae; terminal claw curved, a little longer than that of the second maxillae.

Total length .26 mm.

Remarks.—This species has not been reported since its original discovery by Brian, so that this is the first record from an American locality. Hence a female specimen with an attached male has been deposited in the National Museum with Cat. No. 69846.

Brian gave several figures of the female with a good description, but only a single ventral view of the male without any description. Accordingly the

male is here described in some detail and separate drawings are given of the first and second antenna, the second maxilla, and the maxilliped.

Clavellopsis robusta Wilson

Occurrence.—Only a few specimens found in the axil of the pectoral fin of the mullet.

Clavellopsis strumosa (Brian)

Pl. 12, Figs. 284-290

Clavella strumosa Brian, Copepodi parassiti dei Pesci d'Italia, p. 112, pl. 9, figs. 4-7, pl. 20, figs. 8-12, 1906.

Occurrence.—A few specimens were taken from the gills of the sheepshead *(Archosargus probatocephalus)*.

Female.—Cephalothorax a little longer than trunk, especially in young specimens, inclined towards dorsal surface of trunk; head with dorsal carapace. Trunk dilated, as thick as wide and nearly three times as long; posterior margin trilobed, genital process relatively large. Egg string as long as trunk, nearly half its width.

First antennae 4-segmented with three apical spines and a lateral spine on the second joint. Second antennae biramose, the exopod unsegmented, its anterior margin bearing a number of very short but stout spines; endopod 2-jointed, the terminal segment shorter and narrower and bearing three spines distally.

Mandibles with six acuminate curved teeth, the two middle ones much larger than the others. First maxillae biramose, each branch terminating in a spine; palp shorter with two apical spines. Second maxillae short, separate to their tips where they are slightly thicker and give rise to a short petiole bearing the small round flat bulla. Basal joint of maxilliped large with a spine on the inner margin, the distal one shorter, slender, its inner margin serrated for a short distance, terminating in a slightly curved claw with an accessory spine at its base.

Length of trunk 2.4 mm.; of cephalothorax 2.5 mm.

Male.—General body form like that of *Clavellopsis laciniata*, the genus type, strongly arched dorsally and flattened ventrally, unsegmented.

First antennae 3-jointed, the basal segment a little larger with a seta at the distal corner; third segment tipped with two minute spines and two short setae. Second antennae biramose, the endopod unsegmented and a little shorter than the exopod which is 2-segmented, the basal segment wider and twice as long as the distal which bears a terminal curved spine and whose outer distal margin is armed with short spines.

First maxillae like those of the female, bipartite, the palp tipped with only a single seta. Second maxillae large, the inner distal corner of the basal segment covered with minute spines and hollow, into which the tip of the curved terminal claw shuts. Basal maxilliped segment rectangular, terminal claw large and strongly curved at the tip.

Total length .37 mm.

Remarks.—This copepod was described by Brian as a species of the genus *Clavella* in 1906. In 1915 a new genus, *Clavellopsis*, was established by Wilson to include several *Clavella* species and among them this one of Brian's. The species has not been reported by any other investigator so that this is its first appearance outside of the original Italian habitat. Accordingly a female with an attached male has been placed in the National Museum with Cat. No. 69847. Furthermore Brian did not obtain a male and that sex is here described for the first time.

Clavellopsis longimana sp. nov.
Pl. 12, Figs. 291-303

Occurrence.—A single female with attached male was found in the axil of the pectoral fin of a mullet *(Mugil cephalus)*. Female type Cat. No. 69848, U.S.N.M.

Female.—Cephalothorax a little longer than trunk and flexed back almost at right angles to it and in line with the second maxillae; head not enlarged, with dorsal carapace. Trunk rectangular, posterior margin nearly straight but produced into a short lobe at each corner dorsally and ventrally; a third pair of processes, one on each side of and close to the mid-line, arises from the posterior surface. Egg strings nearly as long as trunk, half as wide anteriorly but tapering to a blunt point.

First antennae 4-jointed, distal segment with three apical spines. Second antennae biramose, exopod unjointed, endopod 2-segmented, the distal segment much shorter and narrower and tipped with two short spines. Anterior half of mandibles with five curved teeth, the first three large. First maxillae 3-segmented, the distal segment very small but armed with a long seta; second joint with one lateral and one distal spine; short palp on basal joint with two terminal setae. Second maxillae slender, as long as the cephalothorax, separate for their entire length; bulla somewhat resembling the corolla of a Petunia. Basal maxilliped joint large, terminal with a short slightly curved claw which has a spine at its base.

Length of trunk 1.7 mm.; of cephalothorax 2 mm.; of egg strings 1.9 mm.

Color.—Body creamy with greyish tinge; eggs flecked with purplish spots.

Male.—Cephalothorax without dorsal carapace, almost at right angles to, and about half the length of, the trunk but twice as wide and separated from it by a groove; trunk arched dorsally, tapering to a point and terminating in two short processes.

First antennae 4-jointed, distal and penultimate joints each with one very small, apical spine. Second antennae biramose, endopod simple with two minute spines; exopod twice as long and 2-segmented, terminal joint with two apical and one lateral spine. Mandibles widened at base, curved at tip and with a few minute teeth. First maxillae 4-segmented, distal joint with two setae; no palp. Second maxillae with large basal joint and slender terminal claw. Maxillipeds 2-jointed with short curved claw.

Total length .72 mm.

Remarks.—The second maxillae are exceptionally long for the genus, hence the specific name, *longimana.*

Brachiella gulosa Wilson

Occurrence.—Found in small numbers on the gills and inner surface of the operculum of the redfish *(Sciaenops ocellatus).*

Brachiella macrura Wilson

Occurrence.—A few specimens on the gills of the banded drum *(Larimus fasciatus)* and the black drum *(Pogonias cromis).*

Brachiella thynni Cuvier

Occurrence.—Very few specimens were found in the axil of the pectoral fin of the bluefish *(Pomatomus saltatrix).*

Brachiella intermedia sp. nov.

Plate 12, Figs. 314-319

Occurrence.—Two females, in company with a few specimens of *Brachiella gulosa,* were taken from the gills and inner surface of the operculum of the redfish *(Sciaenops ocellatus).* Type female Cat. No. 69849, U.S.N.M.

Female.—Cephalothorax cylindrical, considerably longer than trunk and flexed backwards leaving an angle of about 45° between them; head enlarged a little and covered with a dorsal carapace. Trunk one and a half times as long as wide, inflated but flattened dorso-ventrally, with a very small genital process. Two long straight posterior processes, one on either side of the genital process and close to it, all ventral to the egg strings which are much longer than the trunk and more than twice the width of the processes.

First antennae 4-segmented with four apical spines on the distal segment and two on the inner distal corner of the second segment. Second antennae turned down across the frontal margin, the endopod 1-jointed, armed with four short spines; exopod 2-jointed, as large as the endopod, terminating in two blunt spines and two setae. Mandibles narrowed distally with four large and two narrow teeth. First maxillae bipartite, basal portion 2-segmented, palp tipped with two spines. Second maxillae short but separate to the bulla which is button-shaped. At the base of each arm is a large round gland. Maxillipeds with a large basal joint armed on the inner margin with two spine-covered knobs between which is a much smaller projection bearing a single spine; terminal joint slender with a small knob bearing two spines near its base and a terminal curved claw, from the inner side of which arises a short spine.

Length of cephalothorax 2.3 mm.; of trunk 1.67 mm.

Remarks.—This species has been designated *intermedia* because of its close systematic relation with a number of other species of *Brachiella.*

Sphyriidae

Opimia exilis Wilson

Occurrence.—A single female was obtained from the gills of a dusky shark.

PLATE I

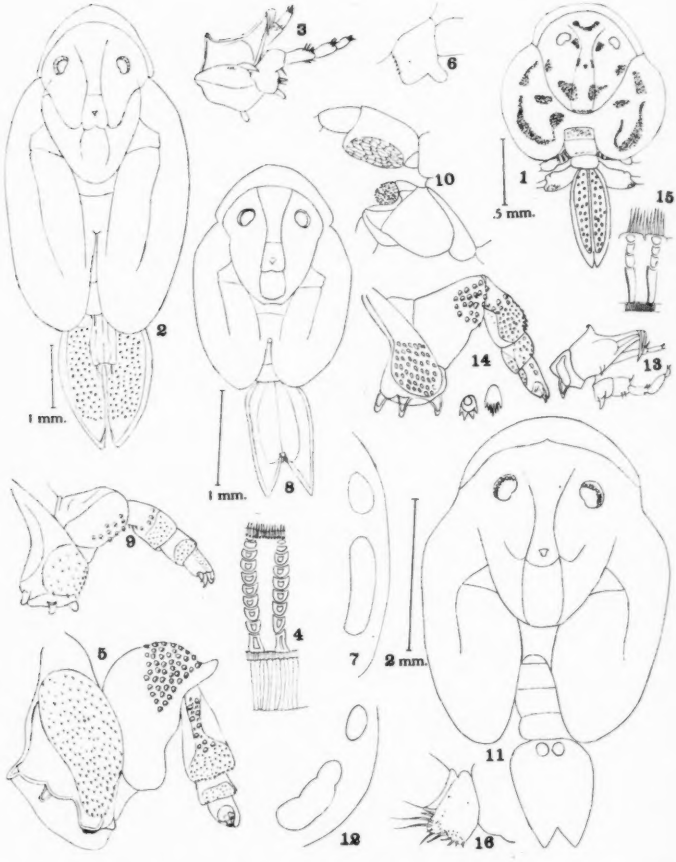


Fig. 1. Dorsal view of male *Argulus funduli*. Fig. 2. Dorsal view of female *Argulus fuscus*. Fig. 3. First and second antenna. Fig. 4. Supporting ribs of sucking disk. Fig. 5. Maxilliped. Fig. 6. Basal joint of fourth leg. Fig. 7. Respiratory areas. Fig. 8. Dorsal view of male *Argulus fuscus*. Fig. 9. Maxilliped. Fig. 10. Basal joints of third and fourth legs. Fig. 11. Dorsal view of female *Argulus varians* from spiny toadfish. Fig. 12. Respiratory areas. Fig. 13. First and second antenna. Fig. 14. Maxilliped. Fig. 15. Supporting ribs of sucking disk. Fig. 16. Basal joint of fourth leg.

PLATE 2

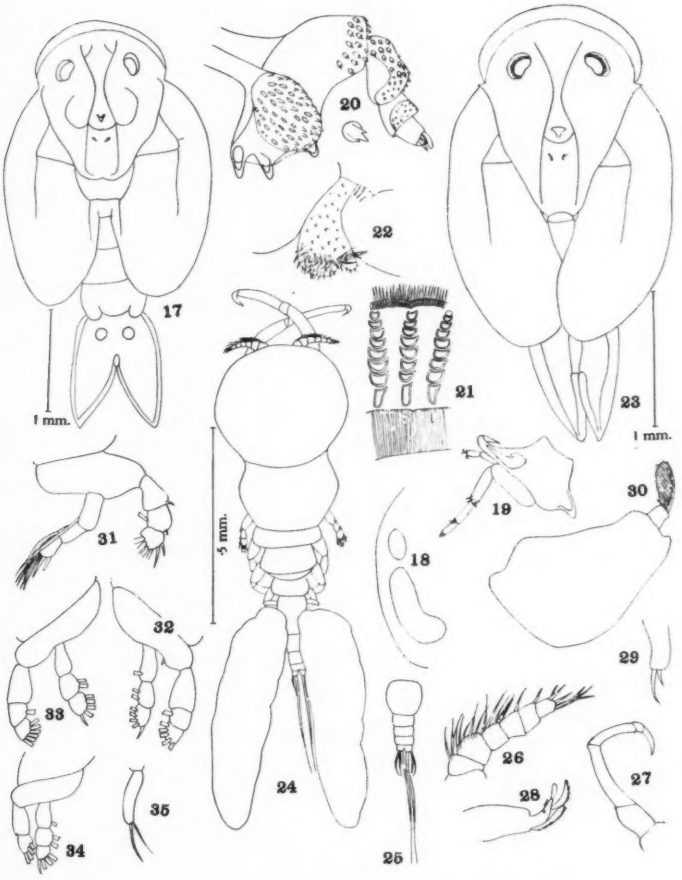


Fig. 17. Dorsal view of female *Argulus bicolor*. Fig. 18. Respiratory areas. Fig. 19. First and second antenna. Fig. 20. Maxilliped. Fig. 21. Supporting ribs of sucking disk. Fig. 22. Basal joint of fourth leg. Fig. 23. Dorsal view of male *Argulus bicolor*. Fig. 24. Dorsal view of female *Ergasilus lizae*. Fig. 25. Genital segment and abdomen. Fig. 26. First antenna. Fig. 27. Second antenna. Fig. 28. Mandible. Fig. 29. First maxilla. Fig. 30. Second maxilla. Figs. 31 to 35. First, second, third, fourth and fifth swimming legs.

PLATE 3

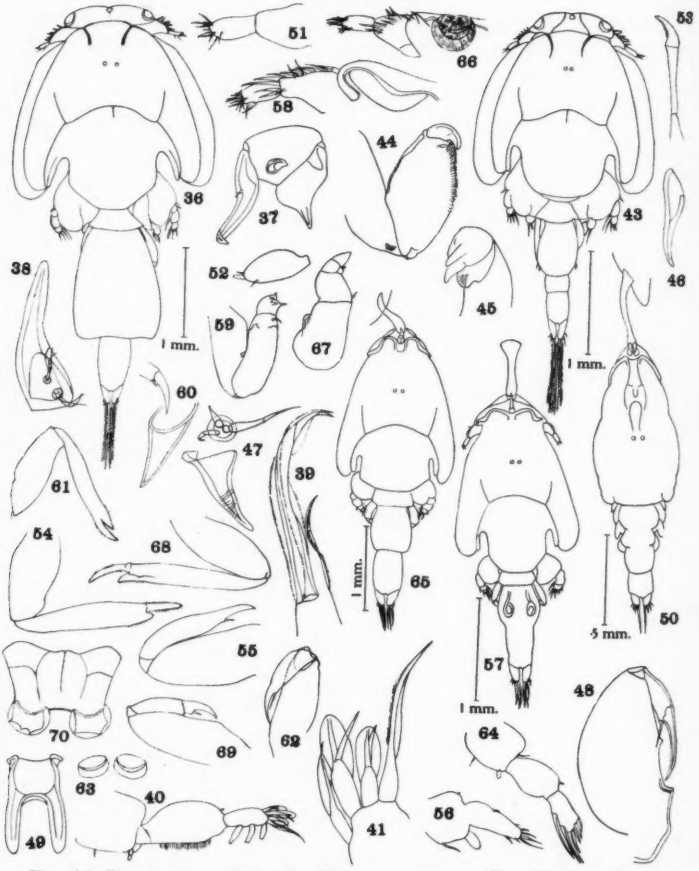


Fig. 36. Dorsal view of female *Caligus praetextus*. Fig. 37. Second antenna. Fig. 38. Prehensile hook. Fig. 39. Terminal claws of second maxilla. Fig. 40. First leg. Fig. 41. Terminal claws of same. Fig. 42. Fourth leg (transferred to Plate 4.). Fig. 43. Dorsal view of male *Caligus praetextus*. Fig. 44. Second antenna. Fig. 45. Terminal claws of same. Fig. 46. Prehensile hook. Fig. 47. First maxilla with palp. Fig. 48. Maxilliped. Fig. 49. Furca. Fig. 50. Dorsal view of chalimus a. Fig. 51. First antenna. Fig. 52. Second antenna. Fig. 53. Mandible. Fig. 54. Second maxilla. Fig. 55. Maxilliped. Fig. 56. First leg. Fig. 57 Dorsal view of chalimus b. Fig. 58. First antenna and lunule. Fig. 59. Second antenna. Fig. 60. First maxilla and palp. Fig. 61. Second maxilla. Fig. 62. Maxilliped. Fig. 63. Furca. Fig. 64. First leg. Fig. 65. Dorsal view of chalimus c. Fig. 66. First antenna and lunule. Fig. 67. Second antenna. Fig. 68. Second maxilla. Fig. 69. Maxilliped. Fig. 70. Furca.

PLATE 4

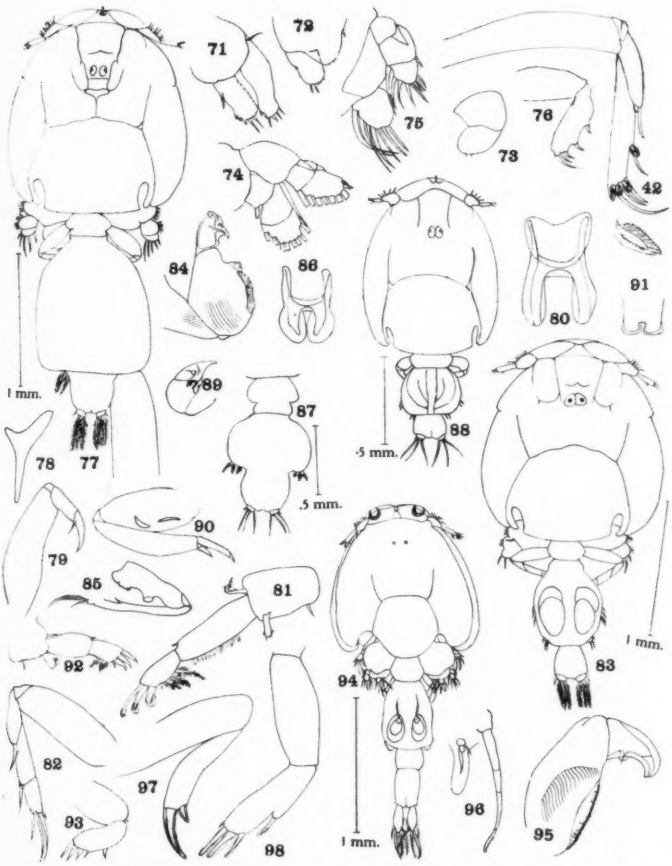


Fig. 42. Fourth leg of *Caligus praetextus* (transferred from Plate 3). Fig. 71. Second leg of chalimus a. Fig. 72. Third leg. Fig. 73. Fourth leg. Fig. 74. Second leg of chalimus b. Fig. 75. Third leg. Fig. 76. Fourth leg. Fig. 77. Dorsal view of female *Lepeophtheirus marginatus*. Fig. 78. First maxilla. Fig. 79. Maxilliped. Fig. 80. Furca. Fig. 81. First leg. Fig. 82. Fourth leg. Fig. 83. Dorsal view of male *Lepeophtheirus marginatus*. Fig. 84. Second antenna. Fig. 85. Second maxilla. Fig. 86. Furca. Fig. 87. Dorsal view of genital segment and abdomen of young female. Fig. 88. Dorsal view of young male. Fig. 89. Second antenna. Fig. 90. Second maxilla. Fig. 91. Furca. Fig. 92. First leg. Fig. 93. Fourth leg. Fig. 94. Dorsal view of male *Echetus typicus*. Fig. 95. Second antenna. Fig. 96. Firsa maxilla and mandible. Fig. 97. Second maxilla. Fig. 98. Fourth leg.

PLATE 5

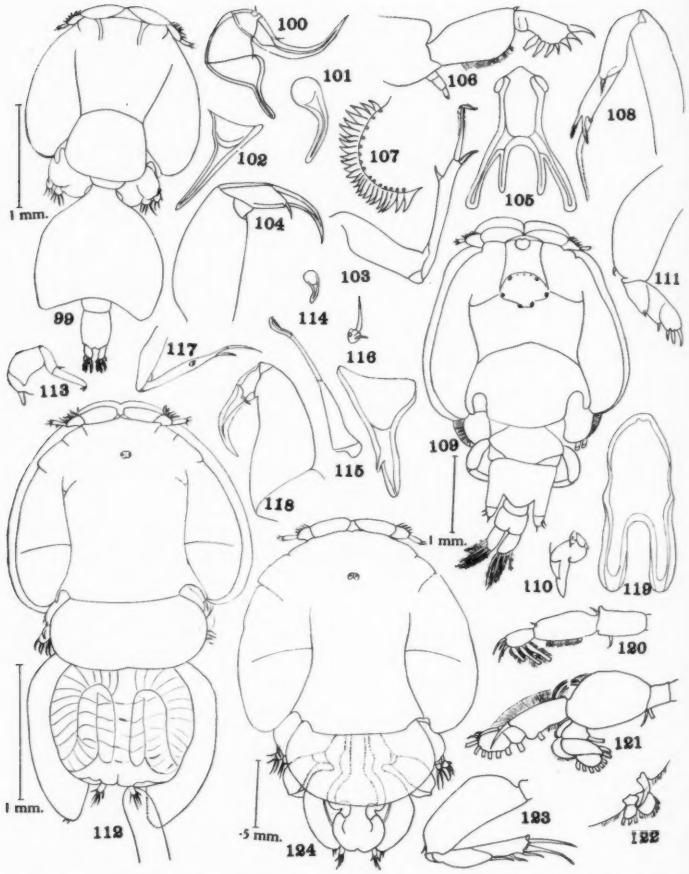


Fig. 99. Dorsal view of female *Lepeophtheirus euris*. Fig. 100. Second antenna. Fig. 101. Prehensile hook. Fig. 102. First maxilla. Fig. 103. Second maxilla. Fig. 104. Maxilliped. Fig. 105. Furca. Fig. 106. First leg. Fig. 107. Teeth on basal joint of second endopod. Fig. 103. Fourth leg. Fig. 109. Dorsal view of immature female of *Gloiopotes crassus*. Fig. 110. First maxilla. Fig. 111. Fourth leg. Fig. 112. Dorsal view of mature female of *Eirgos anurus*. Fig. 113. Second antenna. Fig. 114. Prehensile hook. Fig. 115. Mandible. Fig. 116. First maxilla with palp. Fig. 117. Second maxilla. Fig. 118. Maxilliped. Fig. 119. Furca. Fig. 120. to 123. First, second, third and fourth legs. Fig. 124. Dorsal view of immature female of *Eirgos anurus*.

PLATE 6

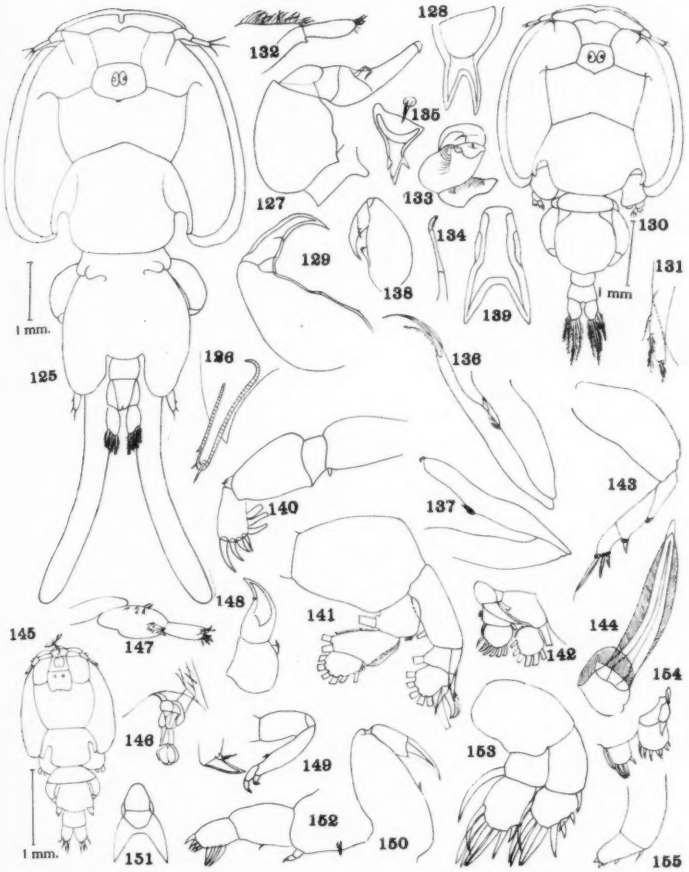


Fig. 125. Dorsal view of *Gloiopotes crassus* female (del. Wilson). Fig. 126. Genital segment process. Fig. 127. Second antenna. Fig. 128. First maxilla. Fig. 129. Maxilliped. Fig. 130. Dorsal view of male *Gloiopotes crassus* (del. Wilson). Fig. 131. Genital segment process. Fig. 132. First antenna. Fig. 133. Second antenna. Fig. 134. Mandible. Fig. 135. First maxilla and palp. Fig. 136. Second maxilla. Fig. 137. The opposite second maxilla (injured ?). Fig. 138. Maxilliped. Fig. 139. Furca. Fig. 140 to 143. First, second, third and fourth legs. Fig. 144. Outer terminal claw of fourth leg. Fig. 145. Dorsal view of chalimus of *Gloiopotes crassus*. Fig. 146. Frontal gland and filament. Fig. 147. First antenna. Fig. 148. Second antenna. Fig. 149. First and second maxilla. Fig. 150. Maxilliped. Fig. 151. Furca. Fig. 152 to 155. First, second, third and fourth legs.

PLATE 7

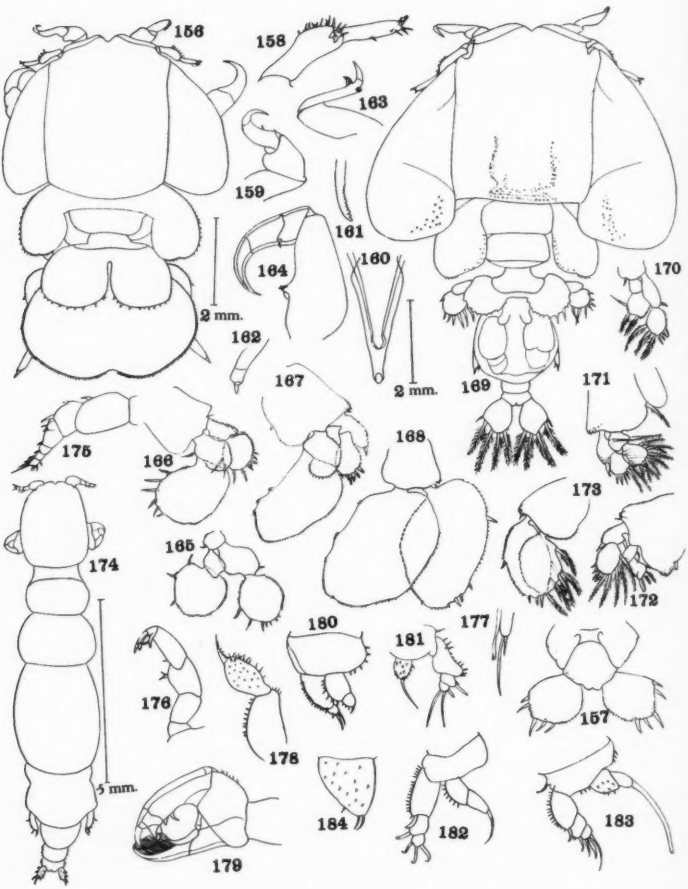


Fig. 156. Dorsal view of female *Entepherus laminipes*. Fig. 157. Abdomen with caudal rami. Fig. 158. First antenna. Fig. 159. Second antenna. Fig. 160. Mouth tube. Fig. 161. Tip of mandible. Fig. 162. First maxilla. Fig. 163. Second maxilla. Fig. 164. Maxilliped. Figs. 165 to 168. First, second, third and fourth legs. Fig. 169. Dorsal view of male. Figs. 170 to 173. First, second, third and fourth legs. Fig. 174. Dorsal view of female *Eudactylina longispina*. Fig. 175. First antenna. Fig. 176. Second antenna. Fig. 177. First maxilla and mandible. Fig. 178. Second maxilla. Fig. 179. Maxilliped. Figs. 180 to 184. First, second, third, fourth and fifth legs.

PLATE 8

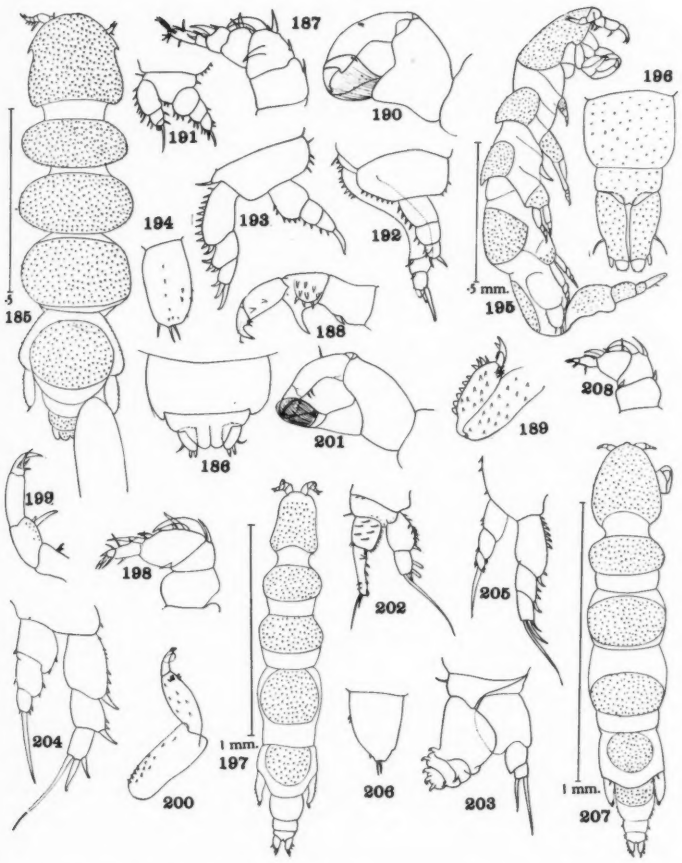


Fig. 185. Dorsal view of female *Eudactylina aspera*. Fig. 186. Abdomen. Fig. 187. First antenna. Fig. 188. Second antenna. Fig. 189. Second maxilla. Fig. 190. Maxilliped. Figs. 191 to 194. First, second, third, and fifth legs. Fig. 195. Lateral view of *Eudactylina aspera*. Fig. 196. Abdomen and caudal rami. Fig. 197. Dorsal view of *Eudactylina turgipes*, female. Fig. 198. First antenna. Fig. 199. Second antenna. Fig. 200. Second maxilla. Fig. 201. Maxilliped. Figs. 202 to 206. First, second, third, fourth and fifth legs. Fig. 207. Dorsal view of female *Eudactylina squamosa*. Fig. 208. First antenna.

PLATE 9

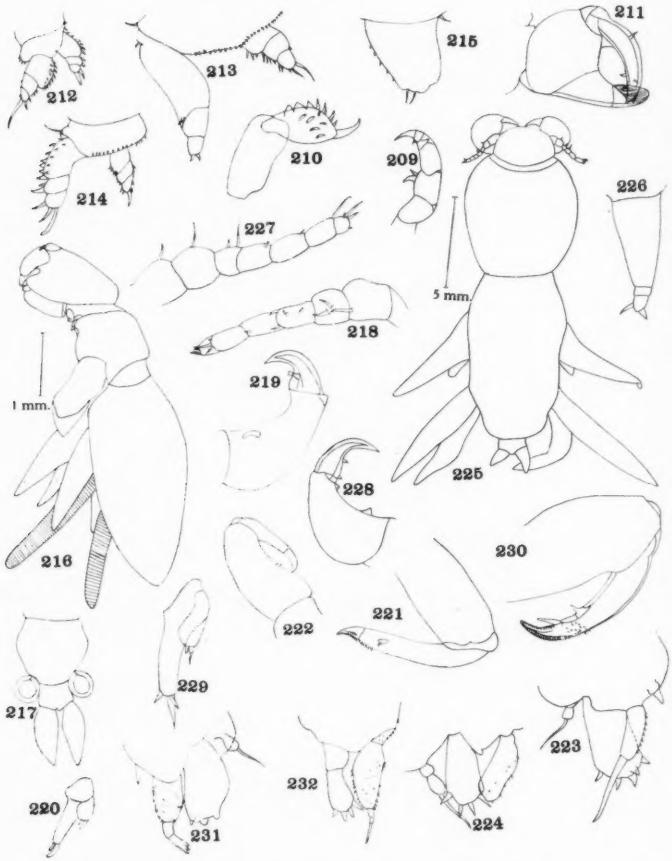


Fig. 209. Second antenna. Fig. 210. Second maxilla. Fig. 211. Maxilliped. Figs. 212 to 215. First, second, third and fifth legs. Fig. 216. Lateral view of female *Lernanthropus pupa*. Fig. 217. Genital segment and abdomen. Fig. 218. First antenna. Fig. 219. Second antenna. Fig. 220. First maxilla. Fig. 221. Second maxilla. Fig. 222. Maxilliped. Fig. 223. First leg. Fig. 224. Second leg. Fig. 225. Dorsal view of male. Fig. 226. Caudal ramus. Fig. 227. First antenna. Fig. 228. Second antenna. Fig. 229. First maxilla. Fig. 230. Second maxilla. Fig. 231. First leg. Fig. 232. Second leg.

PLATE 10

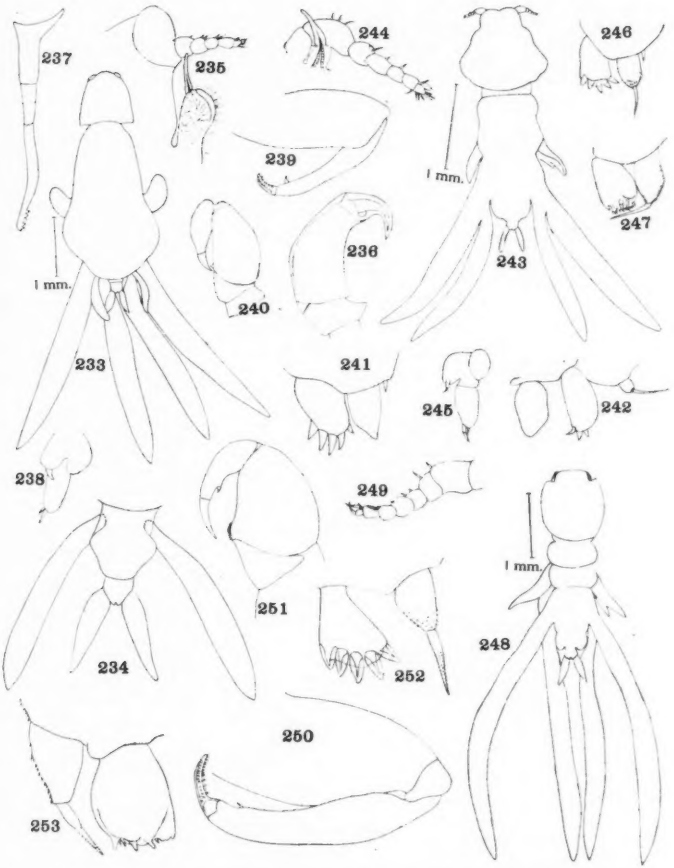


Fig. 233. Dorsal view of female *Lernanthropus gisleri*. Fig. 234. Genital segment and abdomen. Fig. 235. First antenna and prehensile hook. Fig. 236. Second antenna. Fig. 237. Mandible. Fig. 238. First maxilla. Fig. 239. Second maxilla. Fig. 240. Maxilliped. Fig. 241. First leg. Fig. 242. Second leg. Fig. 243. Dorsal view of male. Fig. 244. First antenna and prehensile hook. Fig. 245. First maxilla. Fig 246. First leg. Fig. 247. Second leg. Fig. 248. Dorsal view of male *Lernanthropus longipes*. Fig. 249. First antenna. Fig. 250. Second maxilla. Fig. 251. Maxilliped. Fig. 252. First leg. Fig. 253. Second leg.

PLATE II

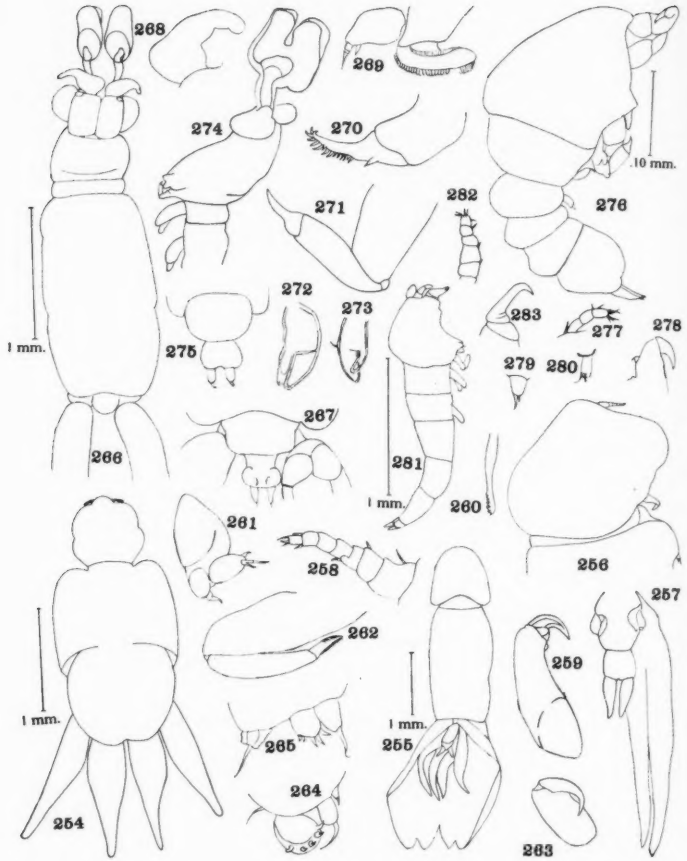


Fig. 254. Dorsal view of female *Lernanthropus kroyeri*. Fig. 255. Dorsal view of *Lernanthropodes cucullus*. Fig. 256. Lateral view of head. Fig. 257. Genital segment, abdomen and fourth legs. Fig. 258. First antenna. Fig. 259. Second antenna. Fig. 260. Mandible. Fig. 261. First maxilla. Fig. 262. Second maxilla. Fig. 263. Maxilliped. Fig. 264. First leg. Fig. 265. Second leg. Fig. 266. Dorsal view of female *Triphyllancanthus ancoralis*. Fig. 267. Genital segment and abdomen. Fig. 268. First antenna. Fig. 269. Mandible and first maxilla. Fig. 270. Second maxilla. Fig. 271. Maxilliped. Fig. 272. First leg Fig. 273. Second leg. Fig. 274. Lateral view of cephalothorax of young female. Fig. 275. Abdomen and genital segment of same. Fig. 276. Lateral view of male. Fig. 277. First antenna. Fig. 278. Second antenna. Fig. 279. First leg. Fig. 280. Second leg. Fig. 281. Copepodid stage of female. Fig. 282. First antenna. Fig. 283. Second antenna.

PLATE 12

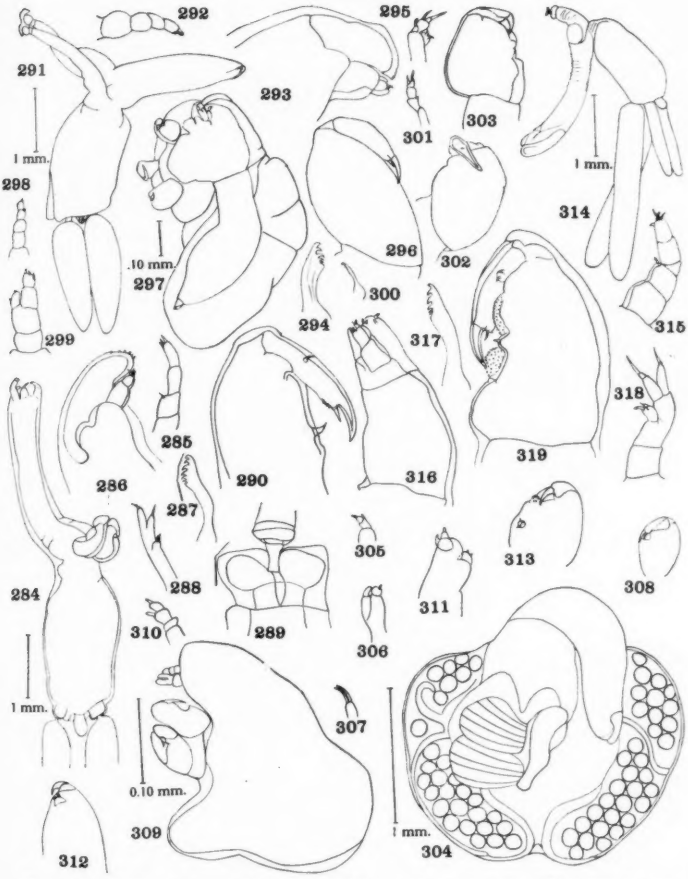
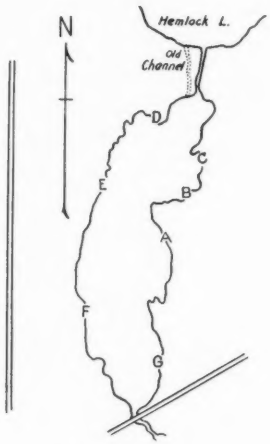


Fig. 284. Ventral view of female *Clavellopsis strumosa*. Fig. 285. First antenna. Fig. 286. Second antenna. Fig. 287. Mandible. Fig. 288. First maxilla. Fig. 289. Tip of second maxillae with bulla. Fig. 290. Maxilliped. Fig. 291. Dorsal view of female *Clavellopsis longimana*. Fig. 292. First antenna. Fig. 293. Second antenna. Fig. 294. Mandible. Fig. 295. First maxilla. Fig. 296. Maxilliped. Fig. 297. Lateral view of male. Fig. 298. First antenna. Fig. 299. Second antenna. Fig. 300. Mandible. Fig. 301. First maxilla. Fig. 302. Second maxilla. Fig. 303. Maxilliped. Fig. 304. Ventral view of female *Naobranchia variabilis*. Fig. 305. First antenna. Fig. 306. Second antenna. Fig. 307. First maxilla. Fig. 308. Maxilliped. Fig. 309. Lateral view of male. Fig. 310. First antenna. Fig. 311. Second antenna. Fig. 312. Second maxilla. Fig. 313. Maxilliped. Fig. 314. Lateral view of female *Brachiella intermedia*. Fig. 315. First antenna. Fig. 316. Second antenna. Fig. 317. Mandible. Fig. 318. First maxilla. Fig. 319. Maxilliped.

An Unusual Naiad Fauna of a Southern Michigan Lake

Henry van der Schalie

During the summer of 1931 the Institute for Fisheries Research at the University of Michigan conducted a series of lake surveys in Hillsdale County, Michigan. Among the lakes surveyed was Carpenter Lake, a relatively small lake, belonging to the St. Joseph River drainage, and situated between two lakes of a series. Incidental to this work a few Naiades were collected. When I received them I doubted the accuracy of the label, inasmuch as the series contained several specimens of *Lampsilis ventricosa,* which I recognized as the river form and unlike anything ever seen before from a lake.



Carpenter Lake

It might be well at this time to make a few remarks on the various forms of this species that are found within the St. Lawrence drainage. Three can be readily recognized. The Great Lakes, together with some of the land-locked lakes of the Southern Peninsula, have developed a very much stunted form, which, in general, is distinct enough to warrant the subspecific name of *canadensis,* which has been given it. Another is one which seems to bridge the gap between the true river form and *canadensis,* resembling the true river form in all respects except size. It is usually somewhat stunted and occurs in lakes of the river-lake type. The river form of the Michigan region is similar

to that found in the Mississippi drainage. It is large, and quite distinct from the river-lake form.

In August of 1931, a few weeks after receiving the shells from the Institute for Fisheries Research, I visited Carpenter Lake to check the accuracy of the data given. I visited a single shoal (see A on chart) and found that river forms were there exactly as reported. The species collected were: *Anodonta grandis footiana* (6), *Lampsilis siliquoidea* (14), *Lampsilis ventricosa* (9), *Micromya iris* (1), and *Strophitus rugosus* (1). This series is of interest since it would indicate that we had here a river-lake. Yet a few of the specimens represented were true river forms.

A year later, September 23, 1932, I again visited this lake in order to learn more about its fauna and the ecological conditions there. At that time the stations shown on the chart were established. I shall briefly give the data obtained, and then attempt to give an explanation for these unusual conditions.

Station A: *Anodonta grandis footiana*—fairly common.
Lampsilis siliquoidea—abundant. This approaches the river form.
Strophitus rugosus—6 specimens.
Lampsilis ventricosa—more abundant here than at any other station.
It was of particular interest that I could not find any *Micromya iris*, though it was found the previous year.

Station B: *Anodonta grandis footiana*—numerous.
Lampsilis siliquoidea—common.

Station C: *Anodonta grandis footiana*—common.
Lampsilis siliquoidea—common.
Lampsilis ventricosa—1 male and 1 gravid female.
This is a fish-spawning bed on the east shore.

Station D: *Anodonta grandis footiana*—abundant.
Lampsilis siliquoidea—common.

Station E: Checked because it was marked as a fish-spawning bed. It was thought that it might offer a place on the west side of the lake where river forms might be found. A careful search was made, but the area did not offer the type of spawning bed found on the east side of the lake. No river forms could be found here; in fact this station was not favorable even for lake forms.

Station F: *Anodonta grandis footiana*—mostly.
Lampsilis siliquoidea—a few. Conditions here were much more boggy. An attempt was made to find river forms, but none occurred.

Station G: *Anodonta grandis footiana*—mostly.
Lampsilis siliquoidea—a few.
Lampsilis ventricosa—1 specimen, a large male.
Strophitus rugosus—1 specimen, full grown.
This station is a fish-spawning bed with ideal bottom and shoal conditions as found at A. Also note that it is found on the east side of the lake, the same side as A.

One of the fundamental questions bearing on this problem relates to the possibility that river-lake conditions exist. With this in mind, the inlet and

outlet were examined relative to flow of water. The inlet, at the south end, was found to have a soft peaty bottom on which grew a luxuriant growth of water-plants, particularly pond-lilies. There was practically no current here, which I believe a more or less permanent condition, considering the silted bottom conditions and the type of vegetation which was dominant. No shells could be found on the soft bottom. This is significant, since I had hoped to find river forms here. Surely river conditions should exist here if such conditions were to be expected anywhere in this lake chain. The outlet of the lake was quite similar to the inlet. There was practically no flow, and there were no indications that river conditions had ever occurred.

With this in mind, it is hardly justifiable to consider this a river-lake. But, grant it to be of this category, the presence of true river forms still must be accounted for. A list of the species of fish recorded for this lake was obtained from the Institute for Fisheries Research. Two species from this list, the Stone Roller and the Horned Dace, are normally river fish and not common to most lakes. Here we have a situation similar to that recorded at the same place for Naiades. The occurrence of these fish may be accounted for in one of two ways: they migrated from neighboring creeks, or they were introduced into the lake by fishermen who used them for bait. I am inclined to believe the latter is the more probable, since in neighboring creeks it does not seem likely that *Lampsilis ventricosa* would occur. This reasoning is based on the records I have for the distribution of *Lampsilis ventricosa* in other drainages.

In conclusion—we are evidently confronted with a situation where an unusual distribution of mussel forms is being brought about passively by humans when they introduce fish parasitized with mussel glochidia from river to lake environments. A more important aspect is not so much the fact that this can take place and is taking place as the fact that such forms are stable enough not to become modified immediately in their new environment.

Museum of Zoology,
University of Michigan,
Ann Arbor, Michigan.

Description of the Larvae of Pseudacris triseriata and Bufo woodhousii woodhousii (Anura)

Karl A. Youngstrom and Hobart M. Smith

During the spring and summer of 1934 and 1935 the senior author undertook a study of the developmental behavior in some of the local forms of Anuran larvae and tadpoles. Two forms, little known in the tadpole stage, were reared successfully from the egg stage to transforamtion. They are *Pseudacris triseriata* (Wied) and *Bufo woodhousii woodhousii* (Girard).[1]

The eggs were obtained either from clasping pairs breeding in the laboratory, or in the field, and positively identified later.[2] The descriptions of the larvae follow.

Pseudacris triseriata (Wied)

Figs. 1, 3, 5, 7

General Appearance.—Tadpole small, maximum total length before metamorphosis 30 to 32 mm.; tail tip obtuse, rounded; tail slightly attenuated toward tip; dorsal crest extended to about the vertical of the spiracle; spiracle sinistral, below lateral axis, directed backward and very slightly upward; spiracle opening round, the inner edge very slightly free from body; eye very slightly dorsal to lateral axis; anus dextral, opening about on the level of the ventral crest. Body uniformly and closely stippled with iridescent bronze; eyes closely stippled with bronze; body quite transparent; dorsal and ventral tail crests with finely scattered pigment areas, dark brown in color (preserved material); dorsal musculature of tail heavily pigmented, ventral musculature slightly less.

Mouthparts.—Labial teeth 2/3. Entire mouth, except a median dorsal space about one-half the length of the upper row of teeth, surrounded by a continuous papillary fringe, which is doubled around the angles of the mouth; this doubled papillary fringe extends downward somewhat medial to the lateral edges of the outer row of lower labial teeth, and above to the lateral edges of the upper labial teeth; a few extra papillae inside fringe at the angles of the mouth; inner row of upper labial teeth divided medially, the two halves separated from each other by about one-half the length of either half; lateral edges

1 So far as can be ascertained no previous descriptions of these tadpoles have been published. The most comprehensive treatise on the tadpoles of American Anura is that of A. H. Wright, 1929, Synopsis and Description of American Tadpoles, Proc. U. S. Nat. Mus. 74: 1-70.

2 See Smith, Hobart M., Amer. Midl. Nat. **15**(4), 1934, for descriptions of the eggs.

of the inner row on upper labium medial to those of the outer row; upper mandible broadly U-shaped, its external edge finely denticulated; length of upper mandible contained in upper row of teeth about one and one-half times; lower mandible V-shaped, its external edge finely denticulated; inner row of lower labial teeth slightly indented medially; and very slightly shorter than second row; outer row approximately one-half the length of the second row, and broadly concave toward the mandible; lateral edges of the two inner rows of the lower labium more or less coincide with the lateral edges of the upper labial rows.

Measurements of a Tadpole at Maximum Length

Total length, 30.0 mm.; body length, 10.0 mm.; body depth (max.), 6.5 mm.; body width (max.), 6.5 mm.; tail length, 20.0 mm.; tail depth (max.), 8.0 mm.; musculature of tail (max.), 2.75 mm.; spiracle to snout, 7.7 mm.; spiracle to vent, 4.8 mm.; spiracle to eye, 3.7 mm.; eye to snout, 2.9 mm.; eye to nostril, 1.6 mm.; nostril to snout, 1.0 mm.; mouth width, 3.0 mm.; interorbital distance, 4.1 mm.; internasal distance, 1.7 mm.

Remarks.—The eggs hatch in from three to five days into free-swimming larvae that are 4.5 to 5 mm. long. The hind legs bud when the tadpoles reach an average total length of 15 mm. The development of the labial teeth is not complete until the hind limbs become motile, at which stage the tadpole is usually 23 to 24.5 mm. long. The outer row of lower labial teeth is the last to appear, being occasionally incomplete at the 25 mm. stage.

Two larvae reared under presumably optimum conditions (room temperature variation from 16 to 30 degrees C. but usually about 22 to 25 degrees C., water temperature always one or two degrees lower; each larva kept in a separate container and supplied with an excess of food) attained a maximum total length of 30 mm. and 32 mm. in 44 and 38 days respectively. Under crowded conditions other larvae required almost twice as long.

Degeneration of labial teeth accompanies the decrease in total length which occurs during metamorphosis. Front limbs do not appear until three to six days after the time at which the tadpole begins to decrease in length.

Decrease in length, regardless of variations in age and size, occurs at about the same rate in all specimens; after the beginning of decrease in length metamorphosis requires about seven days. Successive measurements of one specimen on the fifth and sixth days after the decrease in length had been begun showed a period of extremely rapid decrease in length. At 11:30 a.m. on the fifth day the total length was 21.6 mm.; at 11:30 a.m. on the next day it was 14.5 mm. The length of the newly metamorphosed specimens is about 7.5 mm, from snout to tip of tail remnant.

Bufo woodhousii woodhousii (Girard)

Figs. 2, 4, 6

General Appearance.—Tadpole small, maximum total length 23 mm.; tip of tail rounded, obtuse, not attenuated; dorsal crest extended to a point less

than half-way between anus and the verticle of the spiracle; spiracle sinistral, below lateral axis, directed backward and upward at an angle of about 35 to 40 degrees; opening of spiracle round or slightly oval; inner edge very slightly free from body; eyes dorsal to lateral axis, slightly nearer to median dorsal line than to lateral outline when viewed from above; anus median, opening distinctly higher than the lower edge of the ventral crest. Body and hind limbs heavily pigmented with a very dark brown pigment or gray to slate (specimens preserved in formalin appear more brownish); dorsal musculature of the tail somewhat lighter than the body; ventral musculature immaculate; crests with a few scattered flecks of pigmentation, more numerous in the dorsal crest than in the ventral, the latter being almost immaculate.

Mouthparts.—Labial teeth 2/3. Papillary fringe a single row confined to the angles of the mouth, sharply indented on each side, slightly below the middle; the medial edges of the dorsal papillary fringe extend on each side exactly to the lateral ends of the outer row of upper labial teeth; the medial edges of the ventral papillary fringe extend on each side to slightly medial of the lateral edges of the outer row of lower labial teeth; on each side the dorsal portion of the papillary fringe (i.e. the portion dorsal to the lateral indentation) is slightly shorter than the ventral portion; a few small papillae in the mouth disc above and below the lateral indentations; outer row of upper labial teeth continuous; inner row divided by a space about half the length of either half; lateral edges of the two rows coincide; length of outer row of upper labial teeth about one and one-third times the length of the upper mandible; latter broadly U-shaped, shallow, its external edge finely denticulated; lower mandible V-shaped, its external edge finely denticulated. Inner row of lower labial teeth slightly indented medially, outer neither indented nor broken; inner row the longest of the three, slightly longer than the second, about twice the length of the outer row; inner rows of upper and lower labia about equal in length.

Measurements of a Tadpole at Maximum Length

Total length, 23.0 mm.; body length, 9.4 mm.; body depth (max.), 4.6 mm.; body width (max.), 5.8 mm.; tail length, 13.0 mm.; tail depth (max.), 5.0 mm.; musculature of tail (max.), 2.0 mm.; spiracle to snout, 6.9 mm.; spiracle to vent, 6.1 mm.; spiracle to eye, 4.2 mm.; eye to snout, 2.6 mm.; eye to nostril, 1.0 mm.; nostril to snout, 1.8 mm.; mouth width, 2.5 mm.; interorbital distance, 2.2 mm.; internasal distance, 2.0 mm.

Remarks.—Eggs hatch the third day after deposition; the larvae at hatching are in a premotile condition and measure 2.5 to 3.0 mm. They become free-swimming five to six days after oviposition, when they have attained a length of 6.5 to 7 mm., i.e., about three days after hatching. Hind legs bud at the 10 mm. stage, which represents an age of twelve days or more after oviposition, depending on the environmental conditions such as temperature, nutrition and crowding. Labial teeth are completely developed at the 16 mm. stage (minimum). The hind legs become motile with the attainment of a total length of 20 to 21 mm. The maximum total length of 23 mm. is reached in a min-

imum of thirty-five days; some specimens require nearly twice this period; this length is retained three or four days and then a rapid decrease begins, accompanied by a degeneration of the labial teeth. The front limbs appear about three days after the decrease in total length has begun.

Explanation of Figures

FIGURES

1. Mouthparts of *Pseudacris tristeriata* tadpole, x 18.
2. Mouthparts of *Bufo woodhousii woodhousii* tadpole, x 18.
3. Lateral view of *Pseudacris triseriata* tadpole, x 3.
4. Lateral view of *Bufo woodhousii woodhousii* tadpole, x 3.
5. Lateral view of *Pseudacris triseriata* larva at hatching, x 3.
6. Lateral view of *Bufo woodhousii woodhousii* larva at hatching, x 3.
7. Dorsal view of transforming tadpole of *Pseudacris triseriata*, x 3.

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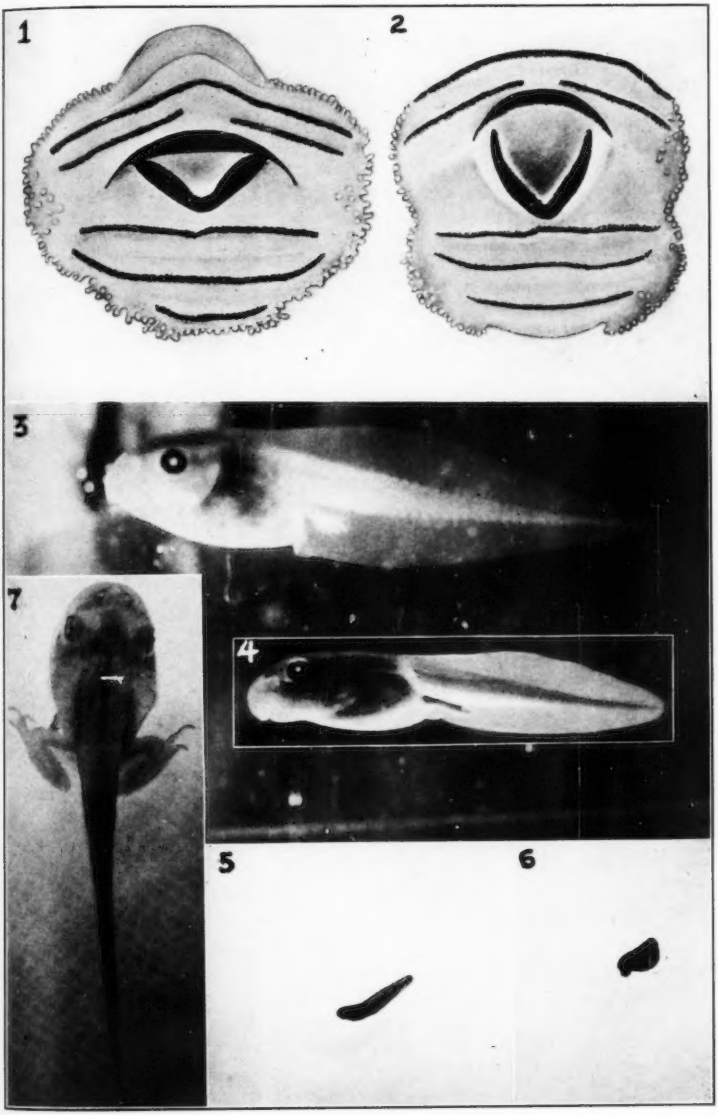
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Amphibians and Reptiles of the Rogue River Basin, Oregon

Henry S. Fitch

The region drained by the Rogue River includes parts of Jackson, Josephine, and Curry counties, in southwestern Oregon, and of Siskiyou and Del Norte counties in northwestern California. Roughly, it is bounded on the east, south, and north by the crests of the Cascade, Siskiyou, and Umpqua mountains. It comprises an irregular area having a maximum breadth of about 120 miles west to east and of perhaps half that distance from north to south.

This area is possessed of varied climate and rough topography. The coastal belt supports dense forests of Douglas fir, coast hemlock, tan oak, California laurel, and Port Orford cedar. To the mouth of the Illinois River at Agness, for more than 40 miles the Rogue River runs through a deep gorge. The region of this gorge, and its counterparts on the tributary Illinois and Applegate rivers, is dry and rugged; Garry and golden oaks, manzanita, and buck-brush *(Ceanothus cuneatus)* are some of the plants most characteristic of the steeper slopes. A few miles west from Grants Pass the head of the main gorge opens out into a valley, most of which is under cultivation. The foothills around the valley include areas of dry, open grassland, as also areas of chaparral, oak, and madrone. At high altitudes this scrub type of forest grades into yellow pine and Douglas fir. Yet higher, discontinuous belts of Canadian and Hudsonian life zones partly surround the valley, forming more or less effective barriers to some species of amphibians and reptiles.

During the 25 years of my residence in this region, I gained general familiarity with its fauna. However, no specimens were preserved and no field notes were written until the summer of 1932. In the summers of 1934 and 1935 I made collections and notes on nearly all the species, and trips were made to parts of the area not previously visited, notably along the lower course of Rogue River. Most of the specimens collected, representing all the species except *Batrachoseps attenuatus* and *Contia tenuis* have been deposited in the Museum of Vertebrate Zoology, University of California. Numbers given are as of the herpetological catalogue in the Museum, unless otherwise indicated. From time to time I have kept under observation in large outdoor cages many individuals of most of the species here discussed.

In the following accounts it is my aim to summarize the geographic, zonal, and ecologic distribution of each form found within the area, and to include observations on its natural history. Specific localities are mentioned for rare species represented by few localities; but for common species represented by many records, these have been summarized in general statements. All localities mentioned may be found on the U. S. Geological Survey topographic maps or on national forest maps.

To members of my family, especially to my father, Mr. Chester Fitch, I am indebted for many specimens and some observations.

Triturus similans Twitty—Oregon Newt

Although newts of the Rogue River Basin seem to be of this species, it is possible that the observations here recorded apply to more than one form.

Newts occur in permanent creeks and ponds throughout the area. On Aug. 2, 1933, at the source of Joe Creek, 6000 feet, Siskiyou Mountains, within a forest of mountain hemlock, many individuals were found in a shallow pool covering about an acre. Two specimens (Mus. Vert. Zool.) were collected on July 16, 1926, at Crater Lake, 6000 feet. The species is not common in swift-running creeks of the dry foothills, and it is absent from streams which dry up in summer. It is most abundant near the coast in slow moving streams, where standing water is always present.

On May 24, 1935, at Lobster Creek, newts were abundant in stagnant pools; most of the females had spawned, but the plump appearance of some in one densely shaded pool indicated they still contained eggs. Five mated pairs of newts in this pool comprised about half the number present. Two single females, evinced interest, in a peculiar manner, in different sticks floating on the surface. One would nose along a stick and then would turn to bring her cloaca to an adjacent position. At the same time she would grasp the stick firmly between her hind legs.

Breeding females had the type of cloaca figured and described by Twitty (1935) as characteristic of *similans*, with lips forming a conical elevation.

I found no eggs of newts under natural conditions, although I often searched for them in pools where breeding adults were abundant. A captive female from Little Butte Creek near Rogue River, deposited eggs singly. On May 15, 1934, numerous larva about an inch long were found in a pond at Burns Creek, Curry County. One was taken from the stomach of a gray garter snake from this locality.

In ten specimens from Lobster Creek, and two from Crater Lake, the palatine teeth are arranged in straight converging series in a V-shaped pattern as figured for *similans* by Twitty.

On May 21, 1935, near Lobster Creek a young newt (no. 18541) apparently newly metamorphosed, head and body length of 34 mm., was dug out of a rock slide in company with Olympic and green-backed salamanders.

Ambystoma macrodactylum Baird—Long-toed Salamander

The long-toed salamander has been collected at widely separated localities within the area, and apparently occurs irrespective of life zone. Slevin (1930, p. 30) records it as abundant at Crater Lake, and seven specimens (Mus. Vert. Zool.) came from this locality. I collected one at Lost Creek, 4000 feet, on July 17, 1932 (no. 14950).

I have found it elsewhere only on the valley floor below 2000 feet. There,

it is the first amphibian to spawn in the spring. The eggs are laid sometimes singly, but more often several in a cluster. Freshly laid eggs have been found between mid-February and mid-March, but none later.

Adults are rarely seen, although judging from the abundance of egg masses, they must be common. During the breeding season I have captured them by dragging a net along the bottoms of shallow pools where the salamanders lie concealed in the mud or under the masses of green algae. At the same time of year, I have found numbers of them together under boards in slimy mud at the edges of the ponds or ditches containing their eggs.

At other times of year no adults could be found in the vicinity of water. It is obvious that during most of the year they are subterranean in habit, because eggs and larvae are found in creeks which dry up completely in summer. In winter and spring, individuals are sometimes found in damp ground at a distance from water. I found five under logs, one under a board pile, and two in holes around roots of trees in an orchard. It is possible that at high altitudes where there is permanent water, the species is more aquatic. The seven specimens from Crater Lake were taken on June 16 and July 16, 1926.

In May, 1935, at Belmont Orchard, 6 miles south of Medford, numerous large larvae were found in an open well about 8 feet deep and 6 feet wide in an orchard. The salamanders stayed near the bottom in muddy water and debris, except when they appeared momentarily at the surface for air, as the larger ones did frequently. Tree-toad tadpoles were swarming at the surface of the water; each one examined had a piece gone from the end of the tail. In some as much as half of the tail was missing.

About twelve salamander larvae were transferred to an aquarium with many of the tadpoles. The salamanders attacked the tadpoles and bit at them whenever they came within reach. Several times a salamander was found swallowing a tadpole whose diameter exceeded that of its own body. The prey was swallowed either head first or backwards. The salamanders caught and killed several tadpoles too large to be swallowed. By the time the last one had disappeared, the salamanders were already attacking each other, and most of them had mutilated fins. They ate small strips of raw meat and chopped earthworms. Most of this lot transformed in June although two had not begun to lose their gills by mid-July.

Some salamanders, kept in the aquarium several weeks after metamorphosis, were clumsy in the water after loss of their gills and broad tail fins. Others transferred to a terrarium seemed to thrive.

Dicamptodon ensatus (Eschscholtz)—Marbled Salamander

The marbled salamander is abundant in the humid coastal region. Farther inland it is less common, but it occurs in certain creeks in dry open woods or in chaparral. In such situations larvae attain large size. Of three larvae over a foot long one was caught by a fisherman in Rogue River south of Table Rock, one was captured in a shallow pool in Birdseye Creek, and another was reported in East Fork, Illinois River by D. H. Johnson. Dry conditions pre-

vailing in these localities seem unfavorable for a large terrestrial salamander. Possibly the species is neotenic in this part of its range.

Two specimens taken in the coastal region at Lobster Creek had already completed metamorphosis although much smaller than those recorded above; 166 mm. and 138 mm. in length.

Stomachs of five larvae from Squaw Creek, 5000 feet, Siskiyou Mountains, contained 2 water beetles, 2 large beetle larvae, a wasp, a caddice fly larva, and unrecognizable remains of other small arthropods. Stomachs of seven larvae from Rogue River, 11 miles from the coast, contained 11 water snails, 12 aquatic insect larvae, a spider and a bug. Two metamorphosed specimens from the same general locality had eaten 3 beetles, a moth, a fly, a land snail having a shell diameter of about 12 mm., and a caddice fly larva with its case.

On several occasions, larvae were found in stomachs of gray garter snakes. On May 26, 1935, a large garter snake *(Thamnophis sirtalis)* which was found at Lobster Creek, disgorged a small adult marbled salamander.

Rhyacotriton olympicus (Gaige)—Olympic Salamander

Heretofore this species has been recorded only from northwestern Washington. In May, 1935, I collected five in a deep, heavily shaded ravine, on the north side of Rogue River, 11 miles above its mouth. None was found in the creek itself. They were dug out from under rock slides, several inches beneath the surface in the saturated basal layer of pebbles and rocks, through which water was seeping slowly. This situation seemed transitional from the aquatic habitat to the damp earth habitat occupied by many species of salamanders.

All five specimens are young; the three smallest still have stumpy external gills. These gills are less than 1 mm. long, being much less conspicuous than in marbled salamanders of the same size. In life the dorsal coloration was brownish with pale gray flecks and white dots along the sides. The ventral coloration was bright lemon yellow (which faded in alcohol) with scattered black dots.

Of the following measurements, for each specimen, the first represents the head and body length to back of thigh in millimeters; the second represents tail length from back to thigh to tip: no. 18562, 40-23 (tail incomplete); no. 2615, H.S.F., 34-20; no. 18564, 29-20; no. 18561, 28-21; no. 18563, 24-18.

Batrachoseps attenuatus attenuatus (Eschscholtz)—Slender Salamander.

The slender salamander has been recorded from Gold Beach (Slevin, 1930, p. 49); apparently this is the northernmost record. I found no specimens.

Plethodon dunni Bishop—Western Green-backed Salamander

This species was collected at only one locality, a ravine on the north side of Rogue River, 11 miles above its mouth. Most of those found were dug out of rock slides. They were active and, when exposed, attempted to escape by running back under the rocks. Some individuals evidently disturbed by

my activity ran out from holes several inches ahead of the point where I was digging. Many escaped.

In life the color pattern of these salamanders closely resembled that of the long-toed salamander: a broad greenish-yellow longitudinal dorsal band, and a gray ventral surface spotted with white. The dorsal band was most brightly colored in the young; in some of the larger adults it was dull brownish yellow, not sharply set off.

The costal grooves, counting one each in the axilla and groin (see Bishop, 1934) and an incomplete one in front of the hind leg, were 15-15 in seventeen of twenty specimens, 16-16 in two, and 15-16 in one.

The largest specimen has a total length of 126 mm.

Plethodon elongatus Van Denburgh—Del Norte Salamander

Two specimens of this salamander were collected along with the series of *P. dunni* discussed above. In both, the costal grooves are 16-16 between (and *not including)* axilla and groin. These specimens are of more slender appearance than *P. dunni,* and have relatively narrower heads which are less distinct from the neck region. On the ventral surface, reticulations of black pigment are denser than in *dunni,* with fewer and smaller white spots. In life the dorsal band was pinkish brown rather than yellow or green.

The larger specimen (no. 2605, H.S.F.) had a head and body length of 49 mm. and a tail length of 49 mm. (from back to thigh to tip). In the smaller specimen (no. 18550,) the same measurements were 23 mm. and 15 mm. Tails were complete in both.

Ensatina eschscholtzii Gray—Oregon Salamander

Two specimens have been collected. One was taken at the head of Poormans Creek, 5 miles southwest of Jacksonville, at the bottom of a 20-foot mine shaft at 2700 feet, in Douglas fir forest. The other was taken in dense forest near the mouth of Silver Creek, about 18 miles inland. The species may be abundant in the coastal region, where little collecting was done.

Aneides ferreus Cope—Clouded Salamander

Six clouded salamanders were found on May 22, 1935, in the coastal forest between Lobster and Silver creeks. Five were taken between the bark and wood within a few square feet, on a large Douglas fir log in space excavated by wood-eating insects. In this space, partly filled with damp particles of wood, the salamanders were hiding with spiders, centipedes, and slugs. Twice, when slabs of bark were broken off partly exposing a salamander, the latter quickly crawled farther up beneath the bark, temporarily escaping. The sixth specimen was found at mid-day beneath bark on a log exposed to direct sunlight.

Stomachs of five of the specimens contained: 2 large orange-colored mites, 1 beetle grub (length 12 mm.), a small beetle, a heavily armored kind of weevil, and some unrecognizable fibrous material.

One specimen contained 12 ova about 4 mm. in diameter.

Ascaphus truei Stejneger—BELL TOAD

On May 21, 1934, I collected two adult males (nos. 17161 and 17162,) 11 miles above the mouth of the Rogue River, in the ravine where green-backed and Olympic salamanders were found. The ground was saturated with moisture and supported a luxuriant growth of ferns and moss. One toad was hopping over rocks where water was seeping down a bank, about fifteen feet from the creek. The other was crouching on a bare spot on a nearly vertical sandstone bank which was damp and nearly covered with moss. Yellow-legged and red-legged frogs and tree toads, and five species of salamanders were collected within a few feet of these places. The stomach of one contained fragments of a small brown beetle; the other a geometrid larva 16 mm. in length, and three small sowbug-like isopods of a kind extremely abundant among rocks along the creek.

In May, 1935, I visited the same ravine and found a Bell toad tadpole 56 mm. long clinging to a rock in the creek, and another adult male. Larvae of marbled salamanders and adult newts were abundant in this same creek.

The following paragraph gives details concerning the capture of the adult:

At one place a small stream entered the main stream, seeping almost entirely beneath a heavy layer of moss. Humps above the general level of the moss marked the positions of stones. I traced this seeping trickle up the bank away from the creek, clearing away stones and moss as I went, and pushing through a thick growth of bushes and tall ferns. Several salamanders *(Plethodon)* were taken as I progressed. When I had reached a point about 50 feet from the creek, I was standing with difficulty on loose sliding soil of the steeply inclined hillside facing a nearly vertical bank where the trickle of water first emerged. A toad hopped on the moisture-saturated moss at my feet. I caught it without difficulty and it proved to be a small male Bell toad. It seemed phlegmatic, and made no vigorous attempts to escape either before or after being captured—in contrast to the behavior of the two species of frogs, occurring there and, to a lesser extent, that of tree-toads.

Bufo boreas boreas (Baird and Girard)—NORTHWESTERN TOAD

This toad ranges throughout the area. At Crater Lake in August, 1930, one was seen several hundred yards out from land swimming between Wizard Island and the shore. A brisk breeze was blowing at the time. On May 26, 1935, one was seen in a cultivated field near the coast, at the mouth of Lobster Creek.

The species is affected favorably by irrigation in the valley. Individuals are often transported, sometimes for long distances, in the irrigation canals. These canals are unsuitable breeding places for some amphibians because of the uncertain supply of water and its turbidity and high temperature. The hardiness of the toad tadpoles and their rapid development usually enable them to complete their larval stage in the canals. In late summer, swarms of young toads are to be found in mud cracks along the edges of the irrigation ditches, or foraging in the evening near-by in the open.

Spawning usually takes place in April, on the floor of the valley, and on the average is several weeks later than that of the tree-toad in the same locality.

Hyla regilla Baird and Girard—Pacific Tree-toad

Locality records indicate that tree-toads occur in all parts of the area. On the valley floor in the vicinity of Medford, the species ordinarily begins to breed about mid-March and continues at least until mid-June. In 1935 tree-toad choruses were heard first in the last week of February. Cold weather in the first week of March temporarily silenced them, but they were heard into July with decreasing volume.

Sluggish streams with mud bottoms which become dry in summer are favorite breeding places. In such situations, many enemies such as garter snakes, newts, and turtles, which might be found in larger creeks, are absent.

Rana aurora aurora (Baird and Girard)—Western Wood Frog

This species occurs only in the humid coastal region. From May 21 to 26, 1935, many were seen in the vicinity of Lobster Creek, but the species was much less abundant than the yellow-legged frog. Most of those seen were several or many yards from the water. They were especially active on warm evenings, foraging among tall ferns and other dense vegetation.

Stomachs of three wood frogs from near Lobster Creek contained 2 small isopods, 6 beetles (the largest 15 mm. in length), a caterpillar 30 mm. long, and a Douglas fir needle. One from 4 miles east of Gold Beach had eaten 4 small isopods and a silverfish (lepismid).

Rana boylii boylii (Baird)—California Yellow-legged Frog

This is probably the most abundant amphibian within the area. It is confined to the immediate vicinity of permanent streams, at least those where water holes persist through the dry season. It is most common along streams having rocky beds, but occurs also in ones having mud bottoms. Most of the stations of occurrence are in low Transition Life Zone or in Upper Sonoran.

Yellow-legged frogs were found in abundance at Evans Creek on April 29, 1934. The majority were small and of nearly uniform size, probably young of the preceding year. Numerous egg masses attached to large pebbles, and newly hatched tadpoles were seen. The spawning places were in pools four or five inches deep where slow currents or eddies caused constant circulation of water around the egg masses.

Stomachs of two specimens from 5 miles east of Gold Beach contained 2 hornets *(Vespa maculata);* 2 carpenter ants, a crane fly, a small dipteran, and a small skipper water strider *(Gerris).* Seven stomachs from 11 miles east of Gold Beach, May 20 to 26, 1935, contained 7 small beetles, 3 mosquitoes, 2 flies, a small moth, a water snail (shell length 10 mm.) and a piece of molted skin.

One of the natural enemies of this species is the gray garter snake. Wher-

ever this snake was found, the frogs were present in abundance and they form a large part of the snake's food as shown by stomach examinations. I have often watched individual gray garter snakes hunting under water, crawling and swimming among rocks, and darting after tadpoles which attempted to escape.

In September, 1929, at Trail Creek my father found garter snakes unusually abundant, and nearly all those seen had eaten at least one yellow-legged frog. The frogs were then concentrated about drying pools or the trickles of water connecting them, and the young were metamorphosing. The actual capture of a frog by a snake was witnessed; the struggling prey was rescued by the observer as the snake was beginning to swallow it. The frog died almost immediately, possibly poisoned by its own dermal secretions introduced into the blood stream through the deep lacerations made by the snake's teeth.

Rana pretiosa pretiosa Baird and Girard—Western Spotted Frog

The spotted frog has been found at only two localities, both in the extreme northeastern part of the area, in the Cascade Mountains. A specimen (no. 17606) was collected August 26, 1934, at Munson Valley, 6700 feet, near Government Camp, Crater Lake National Park, and Slevin (1930, p. 136) has recorded this species from Crater Lake. I collected two specimens (nos. 17185 and 17186) at Whiskey Creek, 4510 feet, on the headwaters of Rogue River. In this locality the creek is cold, deep, and well-shaded, with mossy banks. Canadian Life Zone is indicated there by the presence of lodgepole pine, white pine, and Sitka spruce. Stomach of the two specimens contained three large beetles, a spider, and unrecognizable insect remains.

Sceloporus graciosus gracilis (Baird and Girard)—Mountain Swift

Within the area the mountain swift is limited to Transition Life Zone. It seems to be restricted further to localities where dry, open ground is available. This habitat is present on hillsides so precipitously steep that nearly all debris is washed away, and the ground is swept bare. The lizards may be locally abundant in such places. Golden oak is usually the dominant plant in this habitat.

I have found this swift at Union Creek at Natural Bridge; 6 miles south of Grants Pass; Squaw Creek above Squaw Lake; on the lower Rogue River at Rainie Falls, Bunker Creek and Corral Creek.

In all of these localities but the first, the fence lizard was also present, but not in great numbers. The competition of this larger species may be a limiting factor in the distribution of the smaller one. Both in the wild and with caged individuals, I have noted that the mountain swifts are wary of the larger fence lizards. Males of the former species made threatening displays in the presence of the latter, but retreated when these approached too near. Fence lizards seemed to ignore the presence of the smaller swifts.

Two female mountain swifts collected at Rainie Falls, on May 12, 1934, each contained five developing ova. These and other breeding females seen

on the same date had conspicuous salmon colored markings along the sides and neck.

Sceloporus occidentalis occidentalis (Baird and Girard)—
WESTERN FENCE LIZARD

This species occurs everywhere below Canadian Life Zone in the area, and it is by far the most common species of reptile. Dry open woods in the foothills seem to offer optimum habitat conditions, but the species occurs even in dense forests of tan oak and Douglas fir near the coast.

In 1934 newly hatched young were first seen on July 16, at the Illinois River 3 miles west of Holland. In other years young were not usually seen until the last week of July or the early part of August.

[A record of *Phrynosoma douglasii* from Grants Pass, Josephine County, Oregon (Van Denburgh 1922, p. 375) is probably erroneous. No further evidence of occurrence of any horned toad there could be obtained. In an earlier paper, Van Denburgh (1897, p. 91) gives the locality as "Grants".]

Gerrhonotus coeruleus principis (Baird and Girard)—
NORTHERN ALLIGATOR LIZARD

This alligator lizard is common near the coast, especially along banks of creeks, and in grassy clearings at the edge of the forest. A single specimen from Crater Lake seems to belong to this race, which occurs in the Cascade Mountains farther north. On the coast at Silver Creek and Lobster Creek many were seen during May, 1934 and 1935, but none was seen east of Silver Creek in this region. Apparently this lizard is closely restricted to the humid coastal belt except as it occurs in high mountains in the northeastern part of the area.

Gerrhonotus coeruleus shastensis Fitch—SHASTA ALLIGATOR LIZARD

This race has been found in the southeastern part of the area in the Siskiyou Mountains at Blue Ledge Mine, Squaw Creek, Wagner Gap and Mount Wagner (about 5 miles southwest of Ashland), Griffen Creek, Anderson Creek, U.S. Highway 99 at Siskiyou summit (about 3 miles southeast of Siskiyou Peak), and 10 miles east of Ashland.

Specimens from these localities are not typical of the race *shastensis;* they show intergradation with *principis*. They may be distinguished from typical *principis*, as it occurs near the coast, by absence of light mid-dorsal band; presence of irregularly arranged black marks and of white-tipped scales on the back; lighter ground color of head usually contrasting with ground color of body; heavier keeling of scales; longer tail consisting of more than 100 scale whorls; large azygous prefrontal touching postnasals laterally; sides of frontoparietal more markedly concave.

Gerrhonotus multi-carinatus scincicauda (Skilton)—
OREGON ALLIGATOR LIZARD

This species is abundant throughout the Upper Sonoran and low Transition life zones in the area. Its range slightly overlaps those of *G.c. principis* and of *G.c. shastensis*. My westernmost record of its occurrence is between Silver and Lobster creeks within the humid coastal belt.

The natural history of this form in the Rogue River Valley has been discussed elsewhere (Fitch, 1935).

Eumeces skiltonianus (Baird and Girard)—WESTERN SKINK

Skinks seem to occur everywhere below Canadian Life Zone in the Rogue River drainage. The westernmost record of occurrence is 1 mile west of Lobster Creek about 10 miles from the coast. In rocky open places in the forest the skink sometimes occurs in concentrated colonies. Individuals have been found often under flat rocks on grassy hillsides.

The population of skinks may fluctuate greatly over periods of years. In a pasture of about four acres at Belmont Orchard 6 miles south of Medford on a sidehill strewn with flat rocks, these lizards were formerly so abundant that at least one could be found beneath every large stone. In 1935 they were rare or absent on this hillside. Similar reductions in numbers have been noted at different times in other localities.

One kept for three years in a terrarium remained active all winter at room temperature. It ate cutworms, maggots, earthworms, flies and cockroaches.

Charina bottae (Blainville)—RUBBER SNAKE

Rubber snakes have been recorded definitely from only two localities within the area, Wagner Gap, and 10 miles east of Ashland, both in high Transition Life Zone in Douglas fir and yellow pine forest. At Wagner Gap one was found beneath loose bark of a dead yellow pine two feet above the ground. Another was found in a similar situation only a few inches above the ground. A third was under loose bark on a fallen log. Three specimens collected 10 miles east of Ashland were all found beneath boards on a sawdust pile. This was at the site of an old sawmill which had fallen into decay. The shelter afforded by rotting logs, boards, and debris made the spot favorable for reptiles, skinks, alligator lizards, and fence lizards being unusually common.

One rubber snake when captured disgorged the remains of young meadow mice (probably *Microtus montanus*). At different times, several of these snakes were kept alive in a cage filled to a depth of several inches with old sawdust. They seldom showed themselves at the surface except at dusk. On several occasions they were offered young linnets which they usually ate. The method of attacking and swallowing the prey varied little. The snake crawled around the bird and nosed it for a few seconds, then seize it by the side of the head and quickly threw one or two coils about its body. It would then tighten

its coils for a few seconds, and at the same time would pull and twist on the head of its prey, which was quickly killed.

One captive rubber snake gave birth prematurely to three young. Each was enclosed in an amniotic membrane along with a relatively large mass of yolk. The young made feeble movements; a few hours later they were killed by sunlight falling upon them. Their premature birth was probably a result of the abnormally high temperature at which the mother was kept.

At Fish Lake a man described as the "timber snake," a snake evidently of this species, which occurred locally.

Diadophis amabilis occidentalis Blanchard—Western Ring-necked Snake

All snakes of this species that were seen were in low Transition or Upper Sonoran life zones usually near water. At Belmont Orchard, 6 miles south of Medford one was taken as it was crossing a road, another was found in a dry irrigation ditch, a third was crawling under the edge of a bush of buck-brush *(Ceanothus cuneatus)*. Near Dark Hollow, 7 miles south of Medford one was found coiled under a flat rock. Three snakes from lower Rogue River at Paradise Bar, 1 mile east of Lobster Creek, and 1 mile west of Lobster Creek, respectively, were found crossing trails at mid-day. A large female (no. 17246,) found near Burns Creek on May 15, 1934, contained four ova averaging 20 mm. in length.

Ring-necked snakes in a terrarium ate western skinks on several occasions.

Coluber constrictor mormon (Baird and Girard)—
Western Yellow-bellied Racer

This racer is most abundant in the Upper Sonoran Life Zone but it is also common in Transition Life Zone except in thick coniferous forests. It is common in open woods of Garry oak and poison oak, on grassy slopes, in chaparral, and in grain or hay fields.

On one occasion when my attention was attracted by the squeaking of a mouse in tall grass, I followed up the sound and discovered a yellow-bellied racer attempting to swallow an adult meadow mouse *(Microtus californicus)*.

Two racers cornered at the edges of streams swam across shallow pools in escaping. Often when one is cornered in a bush it will attempt to escape by climbing. I have found individuals hiding under loose bark of trees as high as eight feet above the ground.

Captive yellow-bellied racers ate fence lizards and showed agility in catching them on the run.

Coluber taeniatus taeniatus (Hallowell)—Striped Racer

The striped racer apparently is confined to dry hot and rocky chaparral-covered foothills. It is rare and I have seen only six individuals. One caught in a creek bottom near the mouth of Little Applegate River was climbing

through a willow thicket and was elusive in avoiding capture. Another was found in the road a few miles up the same river. At Big Applegate River near the mouth of Beaver Creek, one was seen crawling rapidly near the edge of the road with its head elevated several inches above the ground. Apparently it had not been alarmed by the observer and seemed unaware of his presence. At Van Dyke Cliffs 5 miles east of Talent one was found basking on a ledge of rock at the edge of the cliffs, and another time one was found near the same spot coiled under a rock. One (no. 18634,) was found crushed on the highway two miles southeast of Gold Hill.

Except the last mentioned one, all were captured alive and kept in a large outdoor cage where they thrived. They ate fence lizards regularly, but did not attack other small animals offered, such as mice, young birds, and alligator lizards. When a fence lizard was thrown near one of the snakes, the latter would dart after it with rapid undulations, and would usually catch the lizard as it scampered and dodged. If the lizard temporarily escaped and hid, the snake would rear high off the ground and advance cautiously, turning this way and that, with sudden jerky motions, prepared to dart in any direction at a movement of the escaping prey. Lizards usually became limp and passive when they were caught by the racers, and then were rapidly swallowed, either head first or backwards, without offering resistance.

Caged striped racers showed indifference to the mid-day sunshine and often they were observed basking, even on summer days, when all other reptiles in the cage, including such desert species as collared lizards and leopard lizards, were in the shade or had sought shelter in burrows.

Pituophis catenifer catenifer (Blainville)—Pacific Gopher Snake

Gopher snakes occur throughout the area below Canadian Life Zone. Specimens have been taken in dense Douglas fir forest (near Squaw Lake), and in pasture land on the coast near Gold Beach, but the species is most common in the cultivated areas of the valley, and in brushland in the foothills.

Near Dark Hollow, 7 miles south of Medford on July 27, 1932, as I was walking down a road which was walled in on either side by dense chaparral thickets of *Ceanothus cuneatus,* I heard the distressed bleating of a rabbit coming weakly and spasmodically from some point near-by in the brush. I turned aside to investigate, and when I had crawled a short distance beneath the bushes, I saw a small jack rabbit *(Lepus californicus),* rolling about and kicking on the ground a few yards ahead of me. Then I saw that it was being attacked by a small gopher snake coiled around it. As the snake attempted to shift its hold, the rabbit regained its feet and ran unsteadily in my direction dragging the snake for several feet before it dropped off. I caught the rabbit when it nearly brushed against me in passing. The snake, possibly alarmed by my movements, climbed up into the chaparral where it was caught 3 feet above the ground. This snake had a total length of 27 inches and the rabbit weighed 195 grams.

Gopher snakes kept in captivity usually accepted small birds and mice as

food when these were offered either alive or freshly killed. Several times fence lizards in the cage were caught and eaten by the snakes.

On one occasion a very small gopher snake had just been placed in the cage a few minutes after being captured. A young meadow mouse taken from its nest, covered with fur but eyes not yet open, was placed in the path of the snake as the latter crawled restlessly about the edge of the cage. The snake stopped suddenly when it discovered the mouse, and struck at it, emitting a sharp hiss as it did so. It then drew back to a defensive pose, and held the forward portion of its body in a S-shaped loop, ready to strike again. In this position it circled around the mouse and struck at it repeatedly, hissing at each inspiration and expiration, and working itself up to a high pitch of excitement. The mouse's movements were feeble, and the snake grew bolder. It struck the mouse with audible impacts, and after each blow bit it before drawing back. Finally it caught the mouse by the head, then retaining this hold, constricted it and quickly killed it. When it was beginning to swallow this mouse, an adult meadow mouse which had been released in the cage approached. The snake hurriedly freed itself from its prey, and struck wildly at the adult. The latter retreated, but the snake retained its defensive pose, meanwhile hissing violently. Eventually it returned to the mouse it had killed and swallowed it.

This snake's behavior seemed to indicate instinctive fear of attack from a parent mouse on whose offspring it was preying. It is probable that a snake of this size if caught unaware in the act of swallowing prey, could be killed easily by an adult meadow mouse.

Several times gopher snakes mated in captivity. A female captured during the breeding season was continually followed by several males in the cage. In preparing to mate the male grasped the body of the female in his jaws. Possibly males recognize the female by scent. A male seeing another gopher snake crawling a few feet away, would pursue it, but after catching up and nosing the other, would quickly lose interest if the second snake happened to be another male.

Lampropeltis getulus boylii (Baird and Girard)—Boyle King Snake

This king snake has been found only in dry hot areas of the valley floor. Three were found near the mouth of Little Butte Creek, in 1924, 1928, and 1929. On April 19, 1934, a king snake (no. 17270,) was found crossing the Crater Lake Highway 1 mile south of Trail. It bit me several times when it was captured. In April 1935 one was collected at the mouth of Birdseye Creek.

In all those seen, the dark bands were black in color, never brownish as they often are in specimens from California.

Lampropeltis zonata (Lockington)—Coral King Snake

The coral king snake is restricted to dryer parts of the area where Garry oak, golden oak, madrone, or chaparral are dominant. It is more widely distributed and abundant than the Boyle king snake in the same region as I have

personally collected or received twenty specimens of the present species and only six of the former species. The twenty specimens represent the following localities: Lake Creek 7 miles south of Brownsboro (no. 17272,); 3 miles east of Phoenix; Belmont Orchard 6 miles south of Medford; Dark Hollow 7 miles south of Medford; Coleman Creek 3 miles southwest of Phoenix; Jacksonville; Big and Little Applegate rivers; East Fork of Illinois River, 1900 feet; and, on the lower Rogue River, Rainie Falls, Solitude Bar, and Horseshoe Bend. Gordon (1935) records it from five additional localities, Wolf Creek, Selma, Grants Pass, Gold Hill, and Sams Valley.

One found dead on the road at the junction of Big and Little Applegate rivers had the tail of a fence lizard and fragments of a green beetle in its stomach. One recently captured disgorged small leathery eggshells which were probably those of either the fence lizard or the western skink.

During the summer of 1934 four adults were kept together in a small cage. They were fed fence lizards which they ate regularly. Evidently the sense of smell plays an important part in finding prey. One would appear to sense the presence of food when it crossed the fresh trail of a lizard. It would become alert and apt to strike at any moving object; often it would seize another snake momentarily. When the lizard was found, it was usually caught by the head. The snake would then throw several coils about it and constrict it. In the meantime a second snake would often find some portion of the lizard exposed between the coils of the first, and would also seize it. Often as many as three snakes attacked the same lizard, enveloping it in a mass of coils from which individual snakes extricated themselves with difficulty after giving up their attempts to appropriate the victim. Skinks were also eaten whenever they were placed in the cage. A half-grown alligator lizard, which was offered, was not eaten but evidently it was attacked as its tail was found to be broken on the following day. An adult rattlesnake, a yellow-bellied racer, and a garter snake, which were placed in the cage at different times were not attacked.

During the latter part of May, shortly after the time of capture, these snakes showed signs of sexual activity. The two smaller individuals, which were males, frequently followed the two females or rested near them. Probably mating did not take place.

Contia tenuis (Baird and Girard)—Sharp-tailed Snake

I have seen only two sharp-tailed snakes from the area. One of these was collected by Professor F. C. Reimer at the Southern Oregon Experiment Station at Bear Creek near Talent. This snake was found coiled under a board near the creek.

Another, which I kept for several months in a terrarium, was collected at the Rogue River near Table Rock. It was secretive and seldom showed itself during the daytime, but it became active and crawled about the cage after dark. It often climbed to the highest point that it could reach and extended its body upward.

Thamnophis ordinoides—WESTERN GARTER SNAKE

Three subspecies of *ordinoides* exist within the general region under consideration, and all three may actually occur in the same locality. Thus near Agness, on May 18, 1934, I collected one of each, all within a radius of 100 yards. There is no sign of intergradation in this region between any two of these forms. Interbreeding is seemingly prevented by factors not yet fully understood. Subspecific ranking of the three forms seems to me justified, after considerable study of the whole group, by the presence elsewhere of intermediate populations; all are ultimately connected as a geographically continuous intergrading series.

Within the Rogue River drainage, all individual *ordinoides* I have examined may be readily identified with one or another of the three subspecies. *T. o. ordinoides* has only seven pairs of supralabials, 17 or 19 scale rows on the body, a small narrow head, and, usually, some red in the coloration. *T. o. elegans* has eight pairs of supralabials, 21 scale rows, a distinct bright yellow dorsal stripe, and a broad heavy head. The third form, differs markedly in its characters from both these subspecies, and it does not agree with any form hitherto described. This previously unnamed race is here designated as:

Thamnophis ordinoides hydrophila subspec. nov.—
OREGON GRAY GARTER SNAKE

Diagnosis.—A member of the *couchii-hammondii* series within the species, having tendency toward reduction of maximum number of scale rows on body from 21 to 19; ground color, gray, dorsal stripe present, and lateral stripe faint or absent.

Description.—Size large, total length as much as 800 mm.; head relatively narrow with pointed muzzle; dorsal stripe faint, less than a single scale row in width for most of its length, tan or pale dirty yellow; lateral stripe faint, or not distinct from color of ventral surface; a checkerboard pattern of two alternating rows of black squares on a gray ground color between dorsal and lateral stripe on each side; supralabials pale gray, almost white on their lower portions, gray or light olive above, narrowly margined with black posteriorly; iris wider than diameter of pupil, uniformly brown or gray in color; chin and throat white except for occasional narrow edges of black between infralabials; ventral surface posteriorly suffused with more or less pink or purple of variable tint; maximum number of scale rows on body 21; the fifth row on each side (when 21 are present) usually reduced and not continuous from head posteriorly to middle of body; supralabials normally 8, 8; infralabials, 10, 10; contact of rostral with both internasals less than contact of rostral with nasal on either side; seventh supralabials relatively small; gastrosteges 154-171, urosteges 74-94.

Type.—Adult male, no. 18127, Mus. Vert. Zool., collected by H. S. Fitch at Trail Creek 6 miles from its mouth, Jackson County, Oregon; July 27, 1934.

Remarks.—Closely allied to *Thamnophis ordinoides couchii.* Differs from *couchii,* as shown by a comparison with a series of ten specimens from the upper Pit River (type locality), as follows: gastrosteges fewer (no overlapping if only specimens of the same sex are compared); infralabials fewer *(couchii* normally has eleven pairs); fewer scale rows across the body (fifth row continuous back to mid-body in *couchii* with occasionally an additional row, making maximum total of 23); ground color paler, grayer, less brown-toned than in *couchii;* no black markings on chin; no conspicuous black blotches on gastrosteges; lateral stripe usually faint, not well set off from ventral coloration.

This subspecies may be distinguished by its light uniformly colored iris from *elegans* and *ordinoides,* both of which have dark, heavily pigmented irises; by its dull indistinct dorsal stripe which contrasts with the bright yellow dorsal stripe of *elegans* and the brick red or chestnut (rarely yellow) stripe of *ordinoides;* by the gray ground color and checkerboard pattern contrasting with the jet black ground color of *elegans* and the usually brownish ground color of *ordinoides;* by the narrower contact of the internasal plates with the rostral exceeded by the contact of the nasal with the rostral on either side. In having 8 pairs of supralabials *hydrophila* differs from *ordinoides* and agrees with *elegans;* it is intermediate but well set off from both as regards number of scale rows and gastrosteges.

This snake is widely distributed and abundant within the area, but it is locally confined to the vicinity of permanent streams having rocky beds. I have collected altogether more than 120 specimens, mostly on boulders at the edge of the water, or in midstream, or crawling and swimming among rocks under water, in search of food. Stomach examinations indicate that nearly all the food is captured in the water. Fish (small trout and *Cottus)* and yellow-legged frogs (both tadpoles and adults) seem to constitute the bulk of the food. One specimen had eaten a larva of the marbled salamander which was 7 inches long. A juvenile had eaten a small newt larva.

There are 76 specimens in the Museum of Vertebrate Zoology collection from the Rogue River basin, and 4 from "Rogue River" in the University of Michigan Museum of Zoology (no. 71513) represent this race.

Thamnophis ordinoides ordinoides (Baird and Girard)—Puget Sound Garter Snake

This garter snake is common in the humid coastal belt, but it becomes rare farther inland. It is characteristic of the moist Transition Life Zone where Douglas fir, alder, California laurel, hazel and broadleaf maple are dominant plants. Specimens have been collected at the following localities: Elk Creek; Squaw Creek 2 miles above Upper Squaw Lake; Evans Creek, 13 miles above mouth; 10 miles east of Ashland; and, on the lower Rogue River, Mule Creek, Kelsey Creek, Clay Hill Creek, Agness, Silver Creek, Lobster Creek, and Gold Beach.

Most of the specimens taken were found on damp ground, often many hundred yards from water. At no time was an undisturbed individual found *in* the water, and stomach examinations showed that only terrestrial animals

were eaten. A total of 19 slugs, 5 plethodont salamanders *(Plethodon* and *Aneides),* and one earthworm were taken from the stomachs of 80 individuals captured in the region around Lobster Creek; many were empty.

In the majority, the dorsal stripe is red, and brick red blotches are present on the abdomen; but the amount of red in the coloration is highly variable. Among more than eighty specimens from the coastal region, none has a yellow dorsal stripe; but among eight that I have seen from the eastern part of the area, two had yellow dorsal stripes and no red in the coloration. It seems probable that the amount of red, and the color of the dorsal stripe, vary geographically as well as individually.

Thamnophis ordinoides elegans (Baird and Girard)—
MOUNTAIN GARTER SNAKE

This subspecies is rare within the area. It usually occurs in the low Transition or Upper Sonoran Life Zone along with Garry or golden oak, madrone, yellow pine, and manzanita. Specimens have been taken at the following localities: Hyatt Dam, 11 miles southeast of Ashland; Emigrant Creek; ridge north of Squaw Lake; Big Applegate River; Little Applegate River; Antelope Creek; Trail Creek; Belmont Orchard, 6 miles south of Medford; Griffen Creek, 8 miles south of Medford; Evans Creek; Rogue River, at Jackson Falls (3 miles northeast of Upper Table Rock); Burns Creek; Solitude Bar; 2 miles west of Agness.

Some adults were found at distances from water, sometimes more than a mile from any permanent stream. Apparently this snake forages in dry woods. Young and half-grown individuals have been found in streams along with gray garter snakes, which latter usually were much the more abundant.

One collected at Applegate River had eaten a small toad. Another taken at Griffen Creek had an adult male fence lizard in its stomach. A captive individual ate a half-grown alligator lizard, and two young yellow-bellied racers.

Although the northernmost published record of this form is Box Springs, eastern Lassen County, California (Grinnell, Dixon, and Linsdale, 1930, p. 152), it is now known to range for north of that locality. In recent years many specimens have been collected in Shasta and Siskiyou counties, California, and a typical specimen (no. 18788,) was taken by me on the Middle Fork of the Willamette River in Lane County, west-central Oregon.

Van Denburgh (1922, p. 823) described two specimens from Siskiyou, Jackson County, Oregon, as intergrades between this form and *atratus.* My examination of these specimens indicates that they are intergrades between *biscutatus* and *hydrophila,* and that they probably came not from Siskiyou itself, which is on the north side of the Klamath-Rogue divide, but from the south or Klamath side a few miles away. A specimen which I collected in that region on Cottonwood Creek, a tributary of the Klamath River, agrees both in color pattern and scalation with the two mentioned specimens. *Elegans,* as it occurs in the Rogue River basin, is typical and does not show intergradation with any other race.

Thamnophis sirtalis concinnus (Hallowell)—Pacific Garter Snake

This garter snake occurs from the crest of the Cascades to the coast wherever there is a permanent water supply, and thus it is the most widely distributed reptile within the area. It is apparently more adaptable than any of the subspecies of *T. ordinoides* and therefore competes with each of these more than they compete with each other. I have observed it hunting its food under water, and foraging both on wet meadowland and on dry ground. Its preferred habitat is on low, wet ground along the edges of marshy meadows and in creek bottoms bordered by thickets of willow and other undergrowth.

Crotalus confluentus oreganus (Holbrook)—Pacific Rattlesnake

Rattlesnakes occur in areas where chaparral, oak and yellow pine predominate. The range extends westward along Rogue River at least to Bunker Creek, where I collected one on May 12, 1934. Persons living in Agness stated that rattlesnakes were common a few miles farther down the river. In 1935, residents at the mouth of Lobster Creek, 13 miles inland from Gold Beach, informed me that a rattlesnake had been killed there several years before. At Gold Beach I was told that rattlesnakes were not of regular occurrence there, but that several individuals found at different times evidently had been brought down the river on floating driftwood.

The species does not seem to occur in cultivated areas on the floor of the Rogue River valley. Probably it has become exterminated there. It is still fairly abundant locally in brushland and in rugged areas in the foothills. An individual killed at Big Applegate River had eaten a wood rat *(Neotoma fuscipes)*. When one taken at Rainie Falls was forced to disgorge, it was found to have eaten a meadow mouse.

Clemmys marmorata (Baird and Girard)—Western Mud Turtle

The mud turtle occurs in most of the permanent streams below the Canadian Life Zone; it is most common along the larger slow-moving creeks which afford deep pools. It occurs along Rogue River for most of its course though not abundantly. On May 20, 1934, several were seen in the river at the mouth of Silver Creek, 15 miles inland.

On April 19, 1934, a large mud turtle was seen crossing the Crater Lake Highway near Trail. It was moving away from the river, and had already progressed about 100 feet up a steep bank. On June 7, 1934, one which I had been keeping since April laid an egg in its cage.

Summary

Nine kinds of salamanders, six frogs and toads, six lizards, thirteen snakes, and one turtle have been recorded from the basin of the Rogue River. New locality records made here extend the known ranges of *Triturus similans, Rhyacotriton olympicus, Plethodon dunni Plethodon elongatus, Gerrhonotus*

multi-carinatus scincicauda, Coluber taeniatus taeniatus, and *Thamnophis ordinoides elegans.*

Three subspecies of *Thamnophis ordinoides* occur within the area, and one of these, *T. o. hydrophila,* is a new race closely related to *T. o. couchii* of California.

Batrachoseps attenuatus, Plethodon elongatus, Gerrhonotus coeruleus shastensis and *Lampropeltis zonata* apparently reach their northern limits in this area; *Rhyacotriton olympicus* and *Plethodon dunni,* have not been recorded farther south.

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Distribution of Races of the Brown Bat (Eptesicus) In Western North America

William L. Engels

The task of identifying and cataloging a series of *Eptesicus fuscus* from Nevada has led me to study the entire series of this bat in the collection of the Museum of Vertebrate Zoology, as well as series from western states borrowed from other institutions and individuals. As a result of this study I am able to define, with a fair degree of accuracy, the ranges of the three races occurring in western North America. Inasmuch as this question is treated only in the broadest terms in Allen's recent paper (1933), and not at all in other publications, I think it justifiable to place my findings on record.

In all, skins and skulls of 493 bats were examined. Of these, 444, representing the races *bernardinus, pallidus* and *peninsulae,* are listed in this paper; the remainder, representing the race *fuscus,* are from eastern states, with the exception of 28 from Kansas. Since the material enabled me to define the western limits of the race *fuscus* only through Kansas, this race is not discussed in the present report.

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Eptesicus fuscus bernardinus Rhoads

1902. *Eptesicus fuscus bernardinus* Rhoads, Proc. Acad. Nat. Sci. Phila., 1901, p. 619. Feb. 6, 1902.

1904. *Eptesicus fuscus melanopterus* Rehn, Proc. Acad. Nat. Sci. Phila., p. 590. Oct. 18, 1904. Type from Mount Tallac, Eldorado County, California.

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1933. *Eptesicus fuscus bernardinus,* Allen, Canad. Field-Nat., vol. 47, p. 32. February, 1933.

Type Locality.—Near San Bernardino, San Bernardino County, California.

Range.—The Pacific coast, from western British Columbia south through western Washington, western Oregon and California to Los Angeles and

Orange counties, west of the Cascade-Sierra Nevada Mountain chain and the Mohave and Colorado deserts (see map).

Characters.—More richly colored than either *pallidus* or *fuscus*, argus brown to raw umber above, Saccardo umber below; larger than *peninsulae* (males: total length more than 105 mm., condylobasal length more than 16 mm.).

Measurements.—Average and extreme measurements, in millimeters, of 6 adult *females* from Dale's, on Paine's Creek, Tehama County, California: length, 118.0 (115-122); tail, 46.8 (43-49); foot, 11 (10-12); forearm (dry), 47.2 (45.5-48.6); condylobasal length, 17.8 (16.9-18.8); zygomatic width, 12.8 (12.1-13.2); greatest cranial width, 8.8 (8.6-9.0); least interorbital constriction, 4.4 (4.1-4.6); width of rostrum, 6.0 (5.9-6.2). For 5 adult *males* from Trout Creek, Tulare County, California: length, 111.4 (107-115); tail, 43.4 (41-47); foot, 9.1 (7-10); forearm (dry), 46.2 (45.1-47.5); condylobasal length, 16.9 (16.7-17.4); zygomatic width, 12.3 (12.0-12.7); greatest cranial width, 8.6 (8.3-9.0); least interorbital constriction, 4.2 (4.1-4.3); width of rostrum, 5.8 (5.6-6.2).

Remarks.—Dicks (1935), in a brief note, remarks that Brown Bats in Washington are very pale in summer, while hibernating bats are uniformly dark. I have at hand the series of winter specimens collected by Mr. Leo Couch at Olympia, Washington, on which these remarks were based; they do average darker than late summer-taken specimens from Oregon. But these very dark variants are not at all uncommon among summer-taken specimens from northern California. Four specimens from Puyallup, Washington, taken in early August, are as dark, as are also two specimens from Vancouver Island, taken in early September. However, two Vancouver Island specimens taken August 30 and September 25 are as bright and rich in dorsal coloration as any specimens seen.

The range of color variation in summer-taken specimens is considerable. and the occurrence of *pallidus*-like individuals (even occasional *fuscus*-like individuals) is so spotty, that real intergradation is difficult to determine; the outline of the range as mapped is, therefore, somewhat arbitrary. In southern California, however, certain series do show gradation. Thus, specimens from the San Jacinto Mountains are somewhat less dark than those from the San Bernardino Mountains and are intermediate between the latter and a series from Escondido, San Diego County, which I consider to be true *pallidus*.

Of 4 specimens from Sisters, Deschutes County, Oregon, one is as richly colored as most coastal specimens, another nearly so. This locality is over the east side of the divide, but still within the humid timbered area; faunal breaks commonly occur through the Deschutes River valley, to the east of Sisters.

Specimens from Washoe and Lyon counties, Nevada, are only tentatively assigned to *bernardinus*. Only four specimens from this part of Nevada are available, and these are all very dark variants, such as occur throughout the range of *bernardinus;* whether *bernardinus* actually extends over the east side

of the Sierras down the Truckee River valley must await more material to be determined.

Specimens examined: Total number, 292, as follows: BRITISH COLUMBIA:—*Vancouver Island:* Errington, 2; Victoria, 3[1]; Esquimault, Mt. Dawes, 1[1]. WASHINGTON:—*Thurston County:* Olympia, 4[2] and 18[3]. *Pierce County:* Puyallup, 5[4]. OREGON:—*Multnomah County:* Portland, 1[3]. *Linn County:* Holly, 1[3]. *Lane County:* Vida, 3[3]. *Deschutes County:* Sisters, 4[3]. CALIFORNIA:—*Del Norte County:* East Fork Illinois river, ¼ mi. S Oregon line, 4. *Siskiyou County:* Kangaroo Creek, 1; Weed, 1; Mt. Shasta, 3; Castle Lake, 1. *Humbodlt County:* Eureka, 4; Carlotta, 1. *Trinity County:* Mad River Bridge, South Fork Mountain, 2; Kohlmenhenger's Ranch, South Fork Mountain, 1. *Shasta County:* McCloud River, near Baird Station, 1; Warner Creek, Lassen Peak, 1. *Lassen County:* Eagle Lake, 2; Grasshopper Valley, 1. *Tehama County:* Mouth of Battle Creek, 1; 1 mi. NE Red Bluff, 1; Dales, on Paine's Creek, 7; 2 mi. W Black Butte, 1; Tehama, 2; Mill Creek, 2 mi. NE Tehama, 1. *Mendocino County:* 3 mi. S Covelo, 1; Sherwoods, 1. *Lake County:* Bartlett Springs, 2[5]; Clear Lake, 1[5]; Long Valley, 9[5]. *Sonoma County:* 7 mi. W Cazadero, 1; 1 mi. W Guerneville, 3. *Napa County:* Putah Canyon, 8 mi. W Winters, 3[5]; Curry Lake, 6[5]. *Yolo County:* Rumsey, 1. *Placer County:* Mt. Stanford, 1; Cisco Butte, 1. *Eldorado County:* Limekiln, Middle Fork American River, 2; Fallen Leak Lake, 1; Fyffe, 10; Calder, 8[5]; Placerville, 9[5]. *Contra Costa County:* Howard Ranch, 10 mi. E Clayton, 11[5]; 8 mi. E Clayton,1[5]. *Alameda County:* Berkeley, 1. *Calaveras County:* West Point, 2[5]; Andreas, 2[5]. *Monterey County:* Monterey, 5; Abbot Ranch, Arroyo Seco, 1; Santa Lucia Peak, 1; Chalk Peak, 3. *San Mateo County:* Pescadero Creek, 4. *San Benito County:* Cook P. O., Bear Valley, 1. *Stanislaus County:* Patterson, 3[5]. *Tuolomne County:* South Fork Stanislaus River, 1. *Mariposa County:* Dudley, 3; Yosemite Valley, 4; Merced Lake, 1; El Capitan Meadows, 9[5]; floor of Yosemite, 3[5]; Tuolumne Meadows, 2[5]. *Madera County:* Raymond, 1. *Fresno County:* Shaver Ranger Station, 3; Kings River Canyon, 4; Hume, 4. *Inyo County:* Robert's Ranch, Weyman Creek, White Mountains, 1; Lone Pine Creek, 3 mi. W Lone Pine, 7. *Tulare County:* Springville, 1; Trout Creek, 6; Taylor Meadows, 1. *Kern County:* Fay Creek, 2; Head of Kelso Valley, 1; East side Levee, Buena Vista Lake, 1; Head of Cuddy Valley, 1; Fort Tejon, 3. *Ventura County:* Mt. Pinos, 3. *Los Angeles County:* Santa Monica, 3[3]; Arroyo Seco Canyon, near Pasadena, 13; Pasadena, 1; Monrovia, 1[5]. *San Bernardino County: San Bernardino Mountains:* Cushenbury Springs, 1; Bear Lake, 2; Bluff Lake, 12; Foresee Creek, 3; Fish Creek, 4; South Fork Santa Ana River, 10; Sugarloaf Mountain, 1. *Orange County:* Trabuco Canyon, 1. *Riverside County: San Jacinto*

1 Provincial Museum, B. C.
2 Leo Couch Coll.
3 Stanley Jewett Coll.
4 Ford Dicks Coll.
5 Leo Wilson Coll.

Mountains: Tahquitz Valley, 2; Hemet Lake, 2; Kenworthy, 4. NEVADA:—*Lyon County:* Wadsworth, 3. *Washoe County:* Incline, 1.

Eptesicus fuscus pallidus Young

1908. *Eptesicus pallidus* Young, Proc. Acad. Nat. Sci. Phila., p. 408. Oct. 2, 1908.

1912. *Eptesicus fuscus pallidus*, Miller, North Amer. Land Mamm. Bull. U. S. Nat. Mus., 1911, p. 62. Dec. 31, 1912.

1918. *Eptesicus fuscus*, H. W. Grinnell (part), Univ. Calif. Publ. Zool., vol. 17, p. 314. Jan. 31, 1918.

1933. *Eptesicus fuscus pallidus*, Allen, Canad. Field-Nat., vol. 47, p. 32. Feb., 1933.

Type locality.—Boulder, Boulder County, Colorado.

Range.—From Alberta and British Columbia east of the Cascade-Sierra Nevada Mountain chain south through the Rocky Mountains and the Great Basin to New Mexico, Arizona, southeastern and extreme southern California and northern Lower California, probably to lat. 30° (see map).

Characters.—Brighter, less richly colored than *bernardinus*, Dresden brown, Saccardo umber or tawny olive above, lighter below, nearly pure white in extremes.

Measurements.—Average and extreme measurements, in millimeters, of 10 adult *females* from Escondido, San Diego County, California: length, 115 (106-122); tail, 46.1 (42-50); foot, 10.8 (10-12); forearm (dry), 46.9 (44.5-50.5); condylobasal length, 16.3 (15.7-17.2); zygomatic width, 12.7 (12.2-13.3); greatest cranial width, 8.7 (8.2-9.3); least interorbital constriction, 4.3 (4.0-4.6); width of rostrum, 5.9 (5.5-6.3). For 6 adult *males* from Escondido, San Diego County, California: length, 110.5 (108-113); tail, 44.7 (41-47); foot, 10.8 (10-11); forearm (dry), 45.8 (44.7-47.6); condylobasal length, 16.0 (15.5-16.4); zygomatic width, 12.2 (11.8-12.6); greatest cranial width, 8.4 (8.2-8.6); least interorbital constriction, 4.1 (3.8-4.4); width of rostrum, 5.9 (5.7-6.1).

Remarks.—This race is apparently more variable in color than *bernardinus*. Dark, richly colored specimens occur throughout its range; one from Barr, Colorado, within 30 miles of the type locality of *pallidus*, has the average color of northern Californian specimens. A series from Eagle Valley, Lincoln County, Nevada, is very pale; a smaller series from the identical locality taken three years later average considerably darker, and are similar to a large series from Greenmonster Canyon, Nye County, Nevada.

While extremely pale individuals only occasionally occur within the range of *bernardinus* (one from Napa County, California) they are very common in the range of *pallidus*, especially in the southwest. Most of a series from La Grulla, Lower California, are tawny olive above, nearly white below.

Specimens examined: Total number, 152, as follows: BRITISH COLUMBIA:

—Vasseaux Lake, Okanagan, 1[1]. WASHINGTON:—*Chelan County:* Stehekin, 1[6]. OREGON:—*Union County:* Palmer Junction, 1[3]. *Klamath Indian Reservation:* Hog Creek, 1[3]. IDAHO:—*Bannock County:* Pocatello, 1. *Adams County:* Black Lake, 1[7]; Bear Creek, SW slope Smith Mountain, 1[7]. UTAH:—*San Juan County:* Navajo Mountain Trading Post, Navajo Mountain, 1. NEVADA:— *Elko County:* Three Lakes, Ruby Mountains, 1[7]. *White Pine County:* Overland Pass, E slope Ruby Mountains, 7[7]. *Lander County:* Peterson Creek, Shoshone Mountains, 1; Birch Creek, 1. *Nye County:* Greenmonster Canyon, Monitor Range, 24; 5 mi. N Hot Creek, Hot Creek Range, 5; Burned Corral Canyon, Quinn Canyon Mountains, 1. *Lincoln County:* E slope Irish Mountain, 1; Eagle Valley, 3.5 mi. N Ursine, 15; 3.5 mi. N Eagle Valley (=3.5 mi. N Ursine), 7. NEW MEXICO:—*Rio Arriba County:* El Rito, 17[8]. *Eddy County:* 30 mi. SW *Carlsbad*, 2[8]. ARIZONA:—*Mohave County:* Nixon Spring, Mt. Trumbull, 2. *Navajo County:* Bat Woman Canyon, 13 mi. W Kayenta, 1. *Pima County:* 20 mi. S Tucson, 1. COLORADO:—*Garfield County:* Newcastle, 1. *Adams County:* Barr, 1[9]. *Yuma County:* Wray, 3[9]; Dry Willow Creek, 1[9]. CALIFORNIA:—*Lassen County:* 8 mi. SW Ravendale, 1. *Inyo County:* Hanapah Canyon, Panamint Mountains, 1. *San Diego County:* Escondido, 18[7] (+2 inMVZ); 6 mi. N Foster, 1; Julian, 5; Cuyamaca Mountains, 4; San Felipe Canyon, 2. *Imperial County:* Colorado River, near Pilot Knob, 1. LOWER CALIFORNIA, MEXICO:—13 mi. N El Mayor, 3; Laguna Hansen, 2; La Grulla, 5; San Jose, lat. 31°, 3.

Eptesicus fuscus peninsulae (Thomas)

1898. *Vespertilio fuscus peninsulae* Thomas, Ann. Mag. Nat. Hist., ser. 7, vol. 1, p. 43. January, 1898.

1912. *Eptesicus fuscus peninsulae*, Miller, North Amer. Land Mamm. Bull. U. S. Nat. Mus. 1911, p. 63. Dec. 31, 1912.

Type Locality.—Sierra Laguna, near lat. 24°, Lower California, Mexico.

Range.—Southern part of Lower California, north probably to lat. 27° (see map).

Characters.—Small (males: total length not exceeding 105 mm.; condylobasal length not exceeding 16 mm.); richly colored above and below.

Measurements.—Average and extreme measurements, in millimeters, for 10 adult *males* from Comondú, Lower California: length, 97.4 (87-105); tail, 41.9 (37-45); foot, 9.4 (8-11); forearm (dry), 41.6 (39.4-43.2); condylobasal length, 15.6 (15.1-16.0); zygomatic width, 11.3 (11.1-11.7); greatest cranial width, 7.8 (7.5-8.0); least interorbital constriction, 3.9 (3.8-4.1); width of rostrum, 5.2 (4.9-5.5).

6 Ralph R. Conner Museum.
7 Ralph Ellis Coll.
8 Kansas Univ. Mus. Nat. Hist.
9 Colorado Nat. Hist. Mus.

Remarks.—Specimens of *peninsulae* can hardly be distinguished on the basis of color from many Californian *bernardinus* or more richly colored extremes of *pallidus*. But while northern Lower Californian (La Grulla) representatives of *pallidus* are varied, many being very pale, specimens of *peninsulae* from Comondú are richer, deeper in color (Sudan brown, antique brown or Brussels brown above; below, near Dresden brown); they are as dark ventrally in the extreme, or darker, than the dorsal coloration of many northern Lower Californian specimens.

Thus, while the size of the species *Eptesicus fuscus* progressively decreases from California down through the peninsula, there is, below La Grulla, a reversal of the accompanying tendency toward paleness, the bats again taking on a rich coloration, which provides a means of recognizing the race *peninsulae*.

Specimens examined: Total number, 15, all from LOWER CALIFORNIA, MEXICO, as follows: Comondú, 11; Pozo Grande, 1; El Medano, 1; Agua Caliente, 2.

General Remarks

The races of *Eptesicus fuscus* considered in this report conform nicely to Bergmann's Law. Progressive decrease in size from north to south is shown especially well by the several series from along the Pacific coast. Females from Tehama County, California, *(bernardinus)*, average 2 to 3 per cent larger, in external measurements, than females from San Diego County *(pallidus)*; skulls of the former average about 9 per cent larger in linear measurements than those of the latter. Males from Monterey and Tulare counties, California, *(bernardinus)*, places from which adequate numbers happen to be available, average 5 to 6 per cent larger, both in total length and length of skull, than males from San Diego County *(pallidus)*. Compared with the southernmost series I was able to examine, males of *peninsulae* from Comondú, Lower California, the Monterey and Tulare County males are 19 per cent larger in total length and 8 to 9 per cent larger in skull length.

There is in the interior, toward the Great Basin, also a gradient of decreasing size, corresponding roughly to a gradient of increasing aridity. Thus, females from Nye County, Nevada, *(pallidus)*, have skulls slightly smaller than those from Eldorado County, California, *(bernardinus)*, at about the same latitude; they are about equal in size to skulls from Inyo County, California, *(bernardinus)*, somewhat farther south.

In making comparisons of size account has been taken of the fact that adult females average 4 to 5 per cent larger than similarly aged males.

General Conclusions

The subspecies of *Eptesicus fuscus* in Canada, the United States and Lower California, Mexico, which seem worthy of recognition, together with their respective type localities, are as follows:

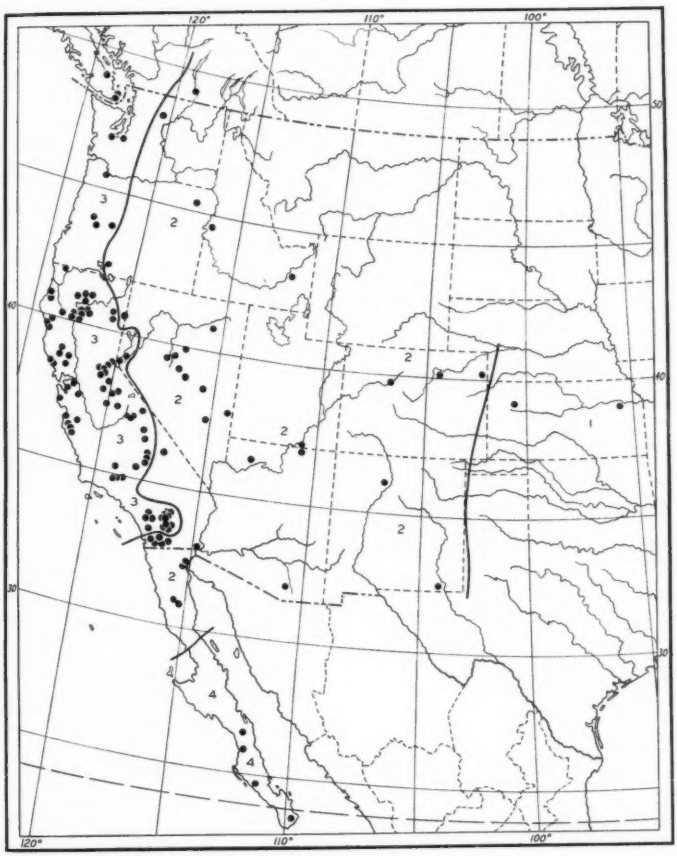

Fig. 1. Map showing localities of occurrence of subspecies of *Eptesicus fuscus* in western North America. Solid circles indicate localities from which specimens have been examined. 1, *Eptesicus fuscus fuscus;* 2, *Eptesicus fuscus pallidus;* 3, *Eptesicus fuscus bernardinus;* 4, *Eptesicus fuscus peninsulae.*

Eptesicus fuscus fuscus (Beauvois). Near Philadelphia, Pennsylvania.

Eptesicus fuscus osceola Rhoads. Tarpon Springs, Hillsboro County, Florida.

Eptesicus fuscus bernardinus Rhoads. Near San Bernardino, San Bernardino County, California.

Eptesicus fuscus pallidus Young. Boulder, Boulder County, Colorado.

Eptesicus fuscus peninsulae (Thomas). Sierra Laguna, near lat. 24°, Lower California, Mexico.

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DICKS, FORD. 1935—Concerning the subspecific status of Big Brown Bats in Washington. The Murrelet **16**:41-42.

MUSEUM OF VERTEBRATE ZOOLOGY,
UNIVERSITY OF CALIFORNIA,
BERKELEY, CALIFORNIA.

Muskrat Habitations of Marsh Island, Louisiana

John D. Mizelle

The following study was made possible during the school year 1932-33 by means of a Louisiana Conservation Fellowship. The author wishes to express his thanks and appreciation to Drs. W. H. Gates and H. J. Bennett of the Louisiana State University, Dr. J. R. Fowler of the Louisiana Polytechnic Institute and to Mr. J. N. Gowanloch, Mr. J. P. Guillot and other members of the Louisiana Conservation Commission for their valuable assistance and guidance.

Observations for a period of six weeks were made on Marsh Island, the location of which is in the Gulf of Mexico off the central Louisiana coast.

Muskrat abodes are of two general types; subterranean spaces containing nests at the end of one or more burrows which open to stream banks; and houses built on the ground surface.

It is significant that on the above named island only the latter type of habitation exists. Banks of all bayous thereon were observed and not a single entrance was noted to indicate the presence of an underground nest. Extremely low tides occasioned by offshore winds greatly facilitated observation. At times the water fell to the extent that at the mouths of many of the bayous it was only from two to three feet deep. It is thought that very low tides, which would ordinarily expose entrances, together with high tides and floods in this area have contributed to the absence of the subterranean type of muskrat abode.

Muskrat houses consist of piles of vegetative materials and mud. Each of these houses possesses nests, systems of radiating tunnels and plunge holes.[1] The animals pile up these materials until a conical-shaped structure of varying height and diameter is reached. Inside are located the nests from which the tunnels or burrows lead down and out into the marsh. Usually the nests are situated above and terminal to, or to one side of the internal plunge or occasionally between two internal openings. The nests are made by eating away the vegetation from below and are floored with finer and softer bits of flora.

The following is a list of the plants found in house construction.

Juncus Roemerianus	Paille chat tigre or needle grass.
Scirpus robustus	Paille des oie or three-cornered grass.
Spartina glabra	Wire grass.

[1] Plunge holes are oval to round opening from six to about sixteen inches in diameter. The mouth of such an opening is generally filled with water in that the tunnels are below the water level in normal weather. Plunge holes may be internal or external depending on whether they open into the nest or to the outside.

Many stems were so decayed that classification was impossible.

When the water starts rising preparatory to floods, the muskrats burrow through the tops of the houses to the outside, making escape easy. Later these holes are plugged when the animals return for reoccupance of the houses. During drouth periods the plunge holes (external) are plugged with mud and vegetation, presumably to conserve moisture.

Excreta were absent in one hundred houses examined. Piles of muskrat dung were found on pieces of floating wood in the water and also on dry ground. Mukrats in the control pen at the Louisiana State University invariably defecated in the water placed in their cage.

The following data were taken from fifty-one muskrat houses:

House Diameter		Size Height	No. of Nests	Nest Diameter		size Height	Dist. from top of house	No. of entrances
5'0"	x	2'6"	1	14"	x	6"	10"	2
3'5"	x	2'6"	1	11"	x	5"	8"	2
3'5"	x	3'2"	1	9"	x	7"	9.5"	3
11'0"	x	5'0"	2	10"	x	5.5"	12"	2
				12"	x	6"	13.5"	
2'6"	x	2'0"	0					
3'8"	x	3'2"	1	12"	x	7"	11"	2
5'0"	x	3'8"	1	13"	x	7"	14"	3
4'6"	x	3'6"	1	13"	x	5"	14"	2
2'5"	x	2'0"	1	8"	x	6"	11"	2
8'6"	x	4'9"	2	12"	x	7"	33"	2
				14"	x	6"	31"	3
4'9"	x	3'2"	1	12"	x	8.5"	24"	3
6'6"	x	3'5"	1	18"	x	9"	31"	4
9'0"	x	5'0"	1	14"	x	7"	38"	3
3'8"	x	2'5"	1	10"	x	7"	12"	2
5'7"	x	3'0"	1	12"	x	7"	11"	3
14'5"	x	4'0"	3	8"	x	6"	18"	2
				8"	x	8"	18"	3
				10"	x	6"	18"	2
6'0"	x	4'7"	1	14"	x	8"	21"	3
5'0"	x	3'9"	1	10"	x	7"	16"	2
6'6"	x	4'6"	1	12"	x	8"	15"	2
4'7"	x	3'9"	1	11"	x	7"	18"	3
8'8"	x	4'2"	1	12"	x	9"	24"	2
8'7"	x	3'1"	1	10"	x	6"	17"	3
6'4"	x	3'6"	1	14"	x	9"	17"	2
5'9"	x	3'6"	1	12"	x	6"	22"	3
9'8"	x	4'3"	1	11"	x	10"	16"	2
4'4"	x	2'9"	1	12"	x	9"	18"	3
5'6"	x	3'2"	1	10"	x	8"	24"	2
16'4"	x	4'3"	2	10"	x	8"	36"	2
				12"	x	8"	22"	2
3'7"	x	2'8"	1	11"	x	7"	19"	2
6'5"	x	3'3"	1	13"	x	8"	27"	2
7'0"	x	3'7"	1	12"	x	6"	28"	3
4'7"	x	4'5"	1	7"	x	8"	27"	3
12'8"	x	4'8"	2	10"	x	6"	33"	2
				10"	x	7"	36"	3
15'7"	x	5'7"	2	11"	x	6"	45"	2
				12"	x	7"	48"	1

4'5"	x	3'8"	1	14"	x	9"	32"	2
4'5"	x	3'8"	1	14"	x	9"	32"	2
8'4"	x	3'11"	1	12"	x	7"	32"	2
5'9"	x	2'11"	1	12"	x	9"	21"	2
9'9"	x	3'0"	1	10"	x	8"	22"	2
4'5"	x	4'0"	1	10"	x	7"	24"	2
7'7"	x	3'8"	1	12"	x	9"	25"	2
6'7"	x	4'5"	1	10"	x	10"	31"	3
4'8"	x	3'8"	1	11"	x	9"	32"	2
4'9"	x	3'2"	1	14"	x	8"	32"	2
6'7"	x	5'0"	1	13"	x	8"	43"	2
8'8"	x	4'9"	1	10"	x	9"	42"	2
3'7"	x	2'10"	1	9"	x	9"	20"	2
3'10"	x	2'11"	1	12"	x	10"	31"	2
4'9"	x	3'4"	1	12"	x	7"	24"	2
6'10"	x	3'5"	1	10"	x	8"	27"	2
7'7"	x	4'0"	1	7"	x	6"	31"	2
Average 6'6"+	x	3'6"	1	13"	x	7.5"	24"	2.3

It is evident from the above data that a wide variation exists in regard to the position of the nest in relation to the top of the house and the ground level.

The number of nests per house varies directly as the size of the house. All houses over 11 feet in diameter contained two or more nests. One house, 8 feet, 6 inches contained two nests whereas other houses of the same diameter and larger, but smaller than 11 feet contained only 1 nest each. As would naturally be expected the number of entrances varies directly with the number of nests present in a given house.

Due to the fact that unmolested muskrats occupy the same house for a number of years, coupled with the fact that the animals constantly add mud and plant material to their habitations year after year suggests that house size may be used to some extent as a criterion of age.

Fires during drouth periods as well as floods and natural enemies probably account to a high degree for the small number of large houses in the area examined.

The population of muskrats, as determined by presence of houses in different parts of the island varies greatly. In some areas no occupied houses exist whereas on other areas there may be anywhere from one to fifty houses present on a single acre of ground. Trappers report that wild geese frequently denude areas of muskrat food so as to cause the animals to migrate to and inhabit new areas. This together with the other agencies mentioned above explains some of the factors operating to cause such wide discrepancies in muskrat populations in different regions of the island.

Note: The house diameter refers to the measurement at the base. Nest size (diameter and height) and distance of nest from the top of the house are given in inches instead of feet and inches as in the case of house size.

DEPT. OF ZOOLOGY,
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Occurrence of the Extinct Moose, Cervalces, in Indiana and in Illinois

Elmer S. Riggs

The presence of *Cervalces* in Indiana has recently been made known to the present writer from a specimen sent to Field Museum by Mr. Oscar Main of Oakland City, Indiana. The specimen, recorded as No. P15143, consists of a dropped antler from the right side. It is at once recognized as belonging to *Cervalces* from the length and straightness of the beam and from the absence of the brow-point common to the modern *Alces*. Dimensions are as follows:

Length of beam to superior branch	315 mm.
Length of superior branch from margin of beam	340 mm.
Greatest diameter of beam at middle	60 mm.

A similar specimen, but one having some sixty millimeters longer beam was collected from Beecher, Will County, Illinois and presented to Field Museum by George Langford in 1919. A second specimen consisting of cranium, atlas, metacarpal, scapula, together with a third beam of antler, all from Minooka, Illinois bog-spring deposit, has been recently reported (Quincy Meeting, May 1, 1936), to the Illinois Academy of Science. These specimens together with others recorded by O. P. Hay, (The Pleistocene of North America. Carnegie Institution of Washington Publ. No. 322, 1923) from Beecher and from Alton, Illinois, and specimens from Big Bone Lick, Kentucky, show that this occurrence in southwestern Indiana is well within the known range of *Cervalces*.

So far as examined by this writer, the specimens from Indiana and from Illinois are too incomplete to admit of specific determination. Five species have already been named, three of which were recognized by Hay. While the known range of the genus extended over Ontario, Pennsylvania, New Jersey and possibly reached Florida, it is doubtful if more than three species will be found valid.

Field Museum,
Chicago, Illinois.

Synusiae as a Basis For Plant Sociological Field Work*

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Recent publications of Lippmaa (1933a, b, 1935) have brought new emphasis to synusiae. His treatment of the vegetation of Esthonia and the Isalnd of Abruka (Abro) on the basis of his one-layered association concept is the first consistent handling of the vegetation of a region strictly based on synusiae. Gams (1918) first described the synusial system of biological units based on both plants and animals. Many plant sociologists have found that a consideration of the synusiae has clarified their concept of the phytocoenoses, the more complex, several-layered, vegetational units. Although many sociologists have described one-layered associations (along with many-layered associations), and certain authors have expressed ideas concerning plant associations which more or less approach Lippmaa's concept, it remained for Lippmaa to elevate the synusiae (homogeneous life-form communities) to the full rank of associations. This method results frequently in several associations occupying the same terrain simultaneously, in fact as many asociations as there are life-form groups in the phytocoenosis.

Lippmaa points out that in the works of Häyrén, Rübel, Wisniewski, Braun-Blanquet, Gams, Du Rietz, and others, there are descriptions of one-layered associations of algae, lichens, bryophytes, herbaceous phanerophytes, shrubs, and even trees, as in the instance of *Piceetum nudum* and *Fagetum nudum*. In this country Conard (1935), in dealing with the plant communities of Central Long Island, has described as associations certain communities each represented by a single synusia: *Suaedetum maritimae, Andropogonetum scoparii, Caricetum strictae,* etc. In all these works the one-layered association ranks equal to the several-layered association in which from two to several synusiae may play a part in the composition of the phytocoenosis.

It is now proposed to discuss briefly the advantages of and the arguments for and against the one-layered association concept and the synusial method. One important advantage of the method lies in the incomparably greater homogeneity of the synusiae as to life-form and habitat factors influencing the community, as well as the reactions involved. This method permits, as Lippmaa has shown, loc. cit., in his studies of the vegetation of Esthonia, that "on the basis of the one-layered association a classification of associations, considering both the dominant life-form of the species forming the association and the habitat conditions, is possible; a thesis already formulated by Flahault,

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Warming, Schröter, and others, but difficulty realizable, if not impossible, in the case of many-layered associations." Lippmaa was able to classify all the associations of Esthonia into seven formations (life-form groups) on a basis of 24 habitat conditions.

A second advantage of the method lies in the fact that in analyzing separately the various synusiae the investigator inevitably pays more attention to the inferior layers than he would if studying the phytocoenosis as a whole. As a consequence of this forced distribution of time and attention among all forms composing the phytocoenosis he is more than likely to ascertain many interesting and important facts concerning the biological phenomena inherent in the complex. For example, much of the important forest site type work of Cajander (1926) and his school is founded on the indicator value of the inferior synusiae—a type of relationship largely neglected by American foresters.

A third advantage of working with the synisiae lies in the mechanics of quadrat sampling which form the basis of statistical description. For example, the writer (1934) has demonstrated that it is impossible to sample adequately all the layers of a stand of forest vegetation by means of a single set of quadrats. Each synusia requires its own minimum quadrat area if only one quadrat per stand is used to ascertain the minimum area on which the community can develop its normal composition and structure. The minimum area, using one quadrat to a stand, may vary greatly for the different synusiae of a phytocoenosis, as much as from 2 to 4 m^2 for bryochamaephyta to about 20 m^2 for the field layer and 400 to 1000 m^2 or more for the phanerophytic synusiae. The details of the sampling problem are somewhat different if several smaller scattered quadrats are used but the underlying principle remains similar. In this connection see the statistical study of the quadrat sampling method as applied by Cain (1935) to spruce and fir asociations in the Great Smoky Mountains.

A fourth advantage of the method lies in the closer correlation of instrumental work with the communities. Ecologists are coming to realize the great quantitative and qualitative differences of the habitat factors in the different synusiae of a complex phytocoenosis.

In addition to the advantages and the practical necessity of considering the synusiae separately when one is analyzing the structure, composition, and habitat relations of a complex piece of vegetation, there are certain arguments for the autonomy, the individuality of some, if not all, of the synusiae. These arguments, which tend to uphold Lippmaa's one-layered association concept, are based on the following facts.

First, many layer communities occur under quite different superior layers. The inferior layers are dependent on the superior layers and the general complex for the modification and amelioration of the habitat, but, in many instances, are not dependent on the specific floristic assemblages producing this amelioration. There are, of course, examples of a close interdependence of species constituting the associated synusiae, but they seem to be less frequent

than examples of a looser interdependence. (Gams (1932, p. 331) says: "The same moss society occurs as a rule in very different phanerogan sociations, consociations, and associations, e.g. the *Pleurozietum Schreberi* and *Hylocomietum splendentis* in the most various heaths, scrubs, and forests." On page 333 he adds, "Different societies in a more or less stabilized phytocenose cohere by more or less strong 'correlations,' which express no kind of floristic relationship and should not be confounded with affinity. On acid bogs and heaths, these correlations are generally stronger than on less acid ones, especially by the reaction of dominant mosses. In woods the reaction due to moss societies is much less than that of trees and shrubs. Coniferous forests however generally have stronger correlations than leafy woods." Sharp and Cain (1936) have studied the bryochamaephytic communities related to several forest types of the Great Smoky Mountains. Some communities, as *Thuidietum* and certain communities of the *Hypnion*, show little correlation with the superior synusiae. Other communities show much stronger correlations. For example, *Hylocomium splendens* of the spruce-fir formation is replaced by *H. brevirostre* in the deciduous forest associations.

Illustrations of the occurrence of a certain synusia (layer) under more than one kind of superior synusiae can be drawn from small-tree communities, from communities of shrubs, herbs, etc., as well as from moss communities. Cain (1934; 557-562) in discussing the association problems and the synusiae calls attention to the occurrence of the small-tree community of *Cornus-Carpinus-Cercis* known to occur under the following forest associations: *Liriodendron Tulipifera-Quercus alba, Quercus alba, Fagus grandifolia-Acer saccharum, Acer saccharum-Tilia glabra.* In Tennessee the author has observed the same community as an understory to *Pinus-Quercus* associes. Lippmaa emphasizes that the *Hepatica triloba-Pulmonaria*-association is dependent on forest humus and shade but largely independent of the floristic nature of the arborescent stratum. One has only to study "Die Buchenwälder Europas" (Rüpel, 1932) to realize in how many combinations (with various synusiae) the *Hepatica triloba-Pulmoniria*-association may occur, and how various, with respect to inferior synusiae, an association can be when the phytocoenosis as a whole is considered to be the association.

Second, many synusiae which occur as inferior layers in one vegetational complex occur elsewhere as the superior layer of a different complex, or occur alone. When such synusiae occur alone no sociologist hesitates to consider the community as an association (or associes), but when the same community occurs as an inferior layer in a phytocoenosis it is supposed to lose its identity, even though keeping its characteristic floristic assemblage and becomes merely a part of an association. For example, the seral stages in a Sphagnum bog complex *(Sphagnum-Oxycoccus; Chamaedaphne-Kalmia; Vaccinium corymbosum-Nemopanthus; Larix)* are readily recognized as associes, i.e. as distinct communities. However, in progressively older communities toward the periphery of these concentric zones, the communities at first separated horizontally become telescoped by the inward migration of the progressively higher synusiae and hence what was once an independent community becomes a layer society.

These layer societies frequently maintain their essential floristic identity. To restate the situation, *Sphagnum-Oxycoccus* as a layer society under *Chamaedaphne, Vaccinium,* and even under *Larix* becomes, in the youngest part of the bog a distinct community where it is dominant. To cite one more example, the author (1930) has described the frutescent heath bald communities of the Great Smoky Mountains. These communities are usually dominated by species of *Rhododendron (minus, catawbiense, maximum), Kalmia, Hugeria, Vaccinium,* etc. These same shrub species, however, form layer communities under the contiguous forest associations *(Abietum, Piceetum, Pinetum).*

Third, the present treatment of associations results in communities of extremely great differences in complexity being placed on an equal basis as associations. Compare the simple maritime associations of *Spartina alterniflora* or *Ammophila breviligulata* with an oak forest such as *Quercetum montanae.* The latter is represented by the following distinct synusiae: superior arborescent layer, inferior arborescent layer, frutescent and herbaceous layers and terrestrial and corticolous cryptogamic synusiae (Cain, 1936). Furthermore, a many-layered phytocoenosis will show considerable variation as to its floristic assemblage, even to the synusial communities present, from place to place over the range of the phytocoenosis. Here and there a certain characteristic frutescent or herbaceous synusia will be absent or replaced by a different but ecologically equivalent community. If these variations in the many-layered associations are due to climatic change it is referred to as faciation, if due to edaphic change, as lociatian—all the time the superior layer on which the many-layered association is based remaining constant. Du Rietz (1930) in his discussion of the "Classification and Nomenclature of Vegetation" remarks that "while the lowest units of phytocoenoses, the sociations, are founded upon relative homogeneity in all layers, most consociations are homogeneous only in one layer, and the higher units in no layer at all, being founded mainly upon the sociological affinity of the dominants of the layer arbitrarily chosen as base for the classification. Thus most phytocoenoses of higher rank than the sociation are natural units only in one layer, each of the other layers consisting of alternating synusiae with very little relationship to each other." If one adheres to the monoclimax theory of vegetation, as do most American ecologists, the association is such a tremendously large, complex, and variable unit of vegetation that it is little wonder that no American forest association in this sense has ever been described adequately. Miss Braun's (1935a, b) recent proposal of the "association-segregate" is a large practical step in the right direction. Not only does this concept emphasize the historic-dynamic aspect involved, but the tree communities thus set up are subject to closer definition and more adequate description. It becomes possible to characterize adequately these smaller and more homogeneous tree associations both on a basis of their composition and structure and on their relations to habitat factors. Considering uniformity and comparability, none of these units is on a par with the synusia. Only on a basis of the latter can a system of community taxonomy be set up wherein the units (the associations) do not vary greatly as to complexity.

In the preceding paragraphs three arguments for basing the association on the synusia have been brought forward, i.e. arguments for Lippmaa's one-layered association concept. Since this paper is not so much a defense of the concept as a consideration of its implications in community taxonomy, and since certain arguments against the method have been propounded, it is desirable that they too be considered.

Pavillard (1935) has recently criticized the attitude of the Upsala group, and, of course, his criticism applies also to Lippmaa's proposal of the method of the one-layered associations. He says, p. 212: "The practical result of the initiative of the Upsala group was . . . to pulverize the vegetation of their respective countries into an innumerable multitude of minute rudimentary groups, under the name of associations, generally covering a very restricted area and corresponding to the lowest rank in the phytosociological hierarchy."

This criticism, I believe, can be answered. That the sociations of Du Rietz (and the synusiae of Lippmaa) are innumerable is hardly the case. Several workers have found it not too great a task to recognize such communities of their region. That they are of restricted area is sometimes true, but many such communities range widely with essential fidelity as to their floristic composition and structure. Followers of Lippmaa's method will, of course, erect large numbers of communities under the name of association. An objection to this can be answered by the fact that the *synusiae exist in nature.* If we recognize them and study them (especially by statistical-sociological methods) we feel the need of a name for them. It seems to me no more complicated to think of *Kalmietum latifolia* as a frutescent association under *Quercetum montanae* than to think of it (along with several other synusiae) as a layer society of the whole phytocoenosis which is the present association of *Quercus montana.* In fact, Conard's (1935) treatment of *Quercetum montanae* (phytocoenosis) as an association is in itself somewhat an innovation in American ecology—the customary treatment considering it at most as a consociation of the larger oak-chestnut association of Weaver and Clements, et al. The taxonomist is not dismayed by several hundred species that constitute a local flora. Why should the plant sociologist hesitate to recognize and name, let us say, one hundred synusiae (if there should be that many) from an equivalent area. The person interested in the larger aspects of vegetation can still refer to the *Quercus montana* forest type, or to the oak-chestnut deciduous forest, etc. He is denied nothing he already has—it is only that what passes strictly as an association is a smaller unit. Lippmaa's method may be compared, within limits, to "splitting" by the taxonomists. Some splitting has been unwise but it must be remembered that the splitters have ascertained and illuminated biological phenomena which otherwise would still be obscure.

Gleason (in personal communication) has, however, brought forward a logical argument against the one-layered association. He points out that in a stand of many-layered vegetation the several life-form groups occupy the same area but do not occupy the same space, yet the plants have definitely an

influence on each other. If we consider one plant, as a shrub or an herb, living under the cover of another the "two plants have intersecting spheres of influence; each interferes with the environment of the other. Widening the extent of such a sphere of influence does not necessarily increase its effect, but merely carries its effect over to other individuals." Considering the influence of the plants on the environment, and in turn on each other, he says, "We are dealing with a matter of physiological interference, which, although located in an area, is not a function of the area. Increasing or decreasing the size of the area does not effect either its nature or its intensity." He continues with the reasoning that each species (lichen, herb, etc.) has its own sphere of influence but that these spheres do not extend far laterally. "The lichens of one tree do not exert the slightest interference on those of the next tree; the herbs of this particular spot do not interfere with those of that spot. There is no dynamic connection between different parts of the same synusia, except the possibility of infection with parasites; there is no genetic connection except through pollination and seed production. On the contrary, the physiological interference of each plant in each synusia affects to a high degree every plant of the other synusiae which lie within its sphere of influence. There is a direct and important connection between the different synusiae both dynamically and genetically." He sums it up well in the following paragraph.

"To bring together into one ecological unit all those plants with intersecting spheres of influence leads to a unit which not only possesses uniformity, but is also a dynamic and genetic unit. To bring together into one unit only those plants which have exactly the same environment, namely, those which form a single synusia, leads to the divorce of cause and effect."

Thus the stand, perhaps with several synusiae, has a logical advantage over the synusia as a unit for the development of the classification concept of the association.

With respect to the second argument above in favor of the synusia as an association Gleason calls attention to the fact that "the great majority of one-layered stands (lone synusiae) may be explained by temporary suppression, or delayed appearance of other synusiae."

In view of the fact that the several synusiae of a phytocoenosis have strong inter-relationships vertically and that within a synusia the horizontal relationships are relatively weak, it seems logical to reject Lippmaa's concept and not to elevate the synusia to the rank of association.

There have not been proposed any arguments against the study of synusiae. Any adequate picture of the complex stand (phytocoenosis) must be synthesized from knowledge of the individual synusiae composing the stand. They are the logical and practical units for field analysis and for ecological instrumentation. By this method, as already pointed out, no existing units are denied. One can still divide the vegetation of a region into associations, consociations, sociations, twin formations, etc., most of them being composed of two or more synusiae.

The concept of the association has been before botanists for a century and many definitions have been proposed and abandoned as they have failed to be adequate on a basis of field investigations. That Lippmaa's one-layered association fails to agree with historic treatment is not necessarily against it. In practice ecologists generally have failed to come to agreement concerning the ranks they recognize in the vegetational hierarchy and the names which they apply to them. However, the "association" in the sense of the Zürich-Montpellier school was reasserted at the Geobotanical Section of the Sixth Botanical Congress, Amsterdam, 1935, where the following resolution was passed unanimously except for Lippmaa and Pavillard:

Recommended: 1. "To use the term 'sociation' for vegetation-units characterized mainly by dominance in the different layers, in the sense of Scandinavian plant sociologists.

2. "To use the term 'association' for vegetation-units characterized mainly in the sense of Zürich-Montpellier plant sociologists, or at least for units of the same order of sociological value; 'subassociation' and 'facies' can, where necessary, be used for their subordinate units.

3. "To unite sociations and associations into 'alliances' in the sense of Zürich-Montpellier plant sociologists, and the alliances into higher units."

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